Microline *

MODEL 38A
F-M TEST SET
(TS-147B/UP)
OPERATION AND MAINTENANCE MANUAL

SPERRY GYROSCOPE COMPANY
DIVISION OF THE SPERRY CORPORATION
GREAT NECK, NEW YORK

PUBLICATION NO. 23-136B

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WARNING

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST OBSERVE ALL SAFETY REGULATIONS AT ALL TIMES. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS OF THE EQUIPMENT WITH THE VOLTAGE SUPPLY ON. ALWAYS REMOVE THE POWER CABLE PLUG FROM ITS RECEPTACLE BEFORE MAKING ANY REPAIRS. UNDER CERTAIN CONDITIONS, DANGEROUS POTENTIALS MAY EXIST IN THE OFF POSITION, DUE TO CHARGES RETAINED BY CAPACITORS, ETC. TO AVOID CASUALTIES, ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM.

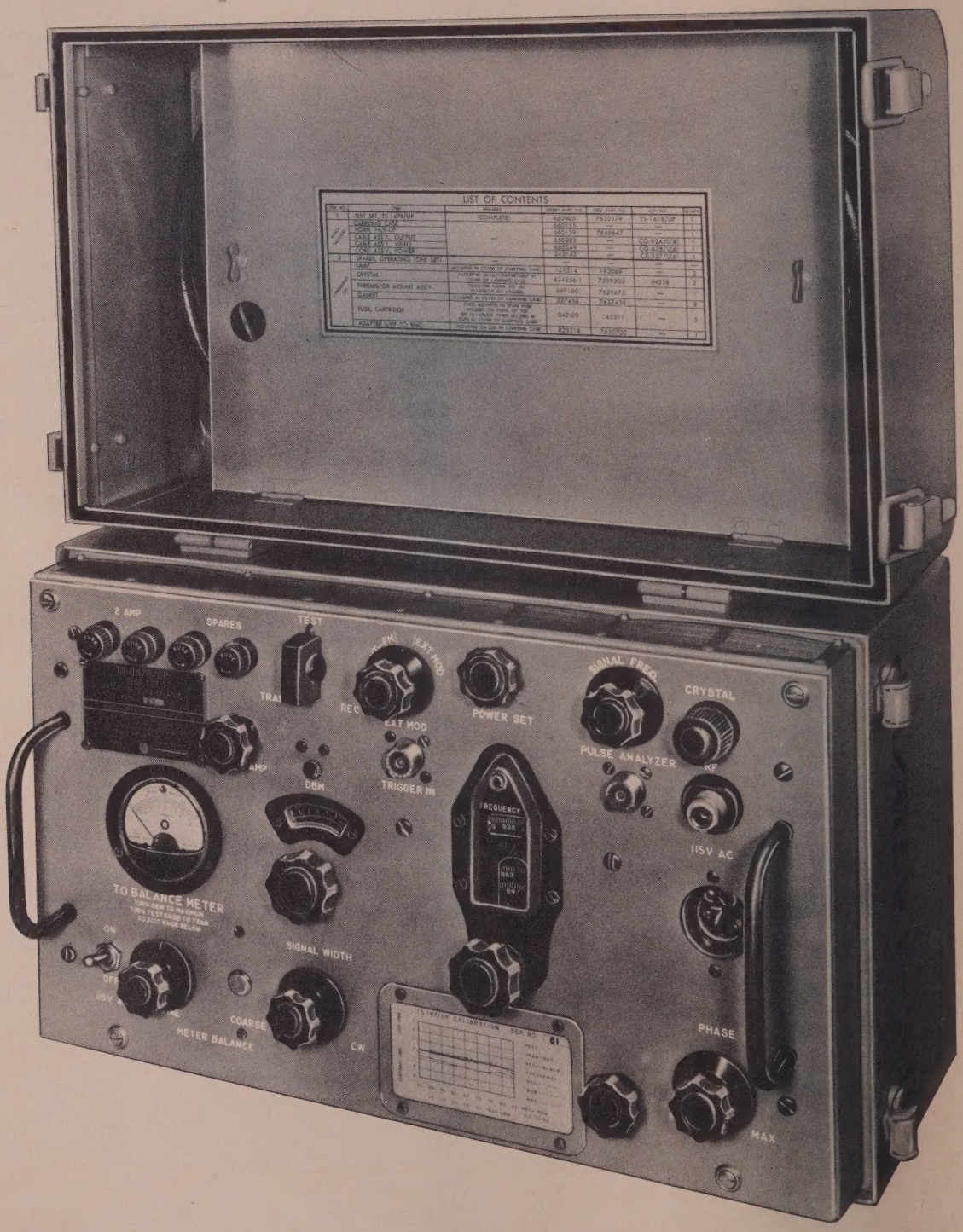

Figure I-1. Model 38A F-M Test Set
Complete Equipment

SECTION I

GENERAL DESCRIPTION

1. GENERAL INFORMATION.

a. Microline Model 38A F-M Test Set* (figure 1-1) is a portable microwave signal generator designed for testing and adjusting radar systems and beacon equipment operating within the frequency range from 8500 to 9600 megacycles per second (mc).

b. The Test Set provides either f-m or c-w microwave test signals of known power level and frequency. These signals, together with the aid of an A-type scan oscilloscope for observing the radar video output, can be used in visual alignment methods for testing and adjusting radar systems. The sweep of the test-signal frequency modulation and the horizontal sweep of the oscilloscope are triggered in synchronism with the radar-system firing cycle. The resulting patterns observed on the A-scope represent the frequency response curve of the receiver section of the radar system since the synchronized timing used causes the horizontal sweep of the A-scope to be proportional to the frequency of the f-m test signals. The oscilloscope patterns, therefore, indicate the effects of system adjustments.

c. In this Test Set provision has also been made to permit observation of the signal envelope of the transmitting tube of the radar system for any indication of power instability.

d. The Test Set contains a direct-reading frequency meter, and a power-level meter which measures power referenced to one milliwatt (dbm). These components are used to measure both the frequency and power level of input or output signals without requiring any accessory equipment. The power-level meter is of the "ruggedized" type to give satisfactory performance under all operating conditions normally encountered in service.

e. This publication is issued as a basic handbook of operating and maintenance instructions. The instructions cover procedures for the application, operation and maintenance of the Test Set. The basic principles and theory of operation are included in Section III for the guidance and information of operating personnel.

2. EQUIPMENT SUPPLIED.

a. The following table shows the equipment supplied. The complete equipment is shown in figure 1-1.

Quan. Per Equipment	*Name of Unit*	*Army-Navy Type Designation*	*Dimensions*			*Weight (Pounds)*
			Width	*Length*	*Height*	
1	TEST SET (complete)	TS-147B/UP	11-1/4 in.	18-3/4 in.	12-1/4 in.	35
1	*HORN, Pickup	AT-68/UP	2-1/4 in.	6-3/4 in.	4-1/2 in.	0.14
1	*CABLE Assembly, Output	CG-92A/U(8)	-	8 ft.	-	1.25
1	*CABLE Assembly, Video	CG-638/U(6)	-	6 ft.	-	1.25
1	+CONNECTOR, Right-Angle Video	Navy-49192A	-	-	-	
1	*CORD Assembly, Power	CX-337/U(6)	-	6 ft.	-	0.13
1	ADAPTER, BNC to UHF	UG-255/U	9/16 in.	1-5/16 in.	-	-
1 Set	*SPARES, Operating (described in par. 4.*g.*)	-	-	-	-	-

* Items packed in cover of Test Set carrying case.

+ Attached to Video Cable CG-638/U(6).

3. EQUIPMENT REQUIRED BUT NOT SUPPLIED

a. The following equipment must be used with the Test Set for most of the applications in testing radar systems: Oscilloscope TS-34A/AP (or TS-239/UP) for receiver tests; 20-db Directional Coupler for quantitative power measurements.

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* The Model 38A Microline F-M Test Set, hereafter simply referred to as the Test Set throughout the text of this Operation and Maintenance Manual, is the equivalent of Test Set TS-147B/UP.

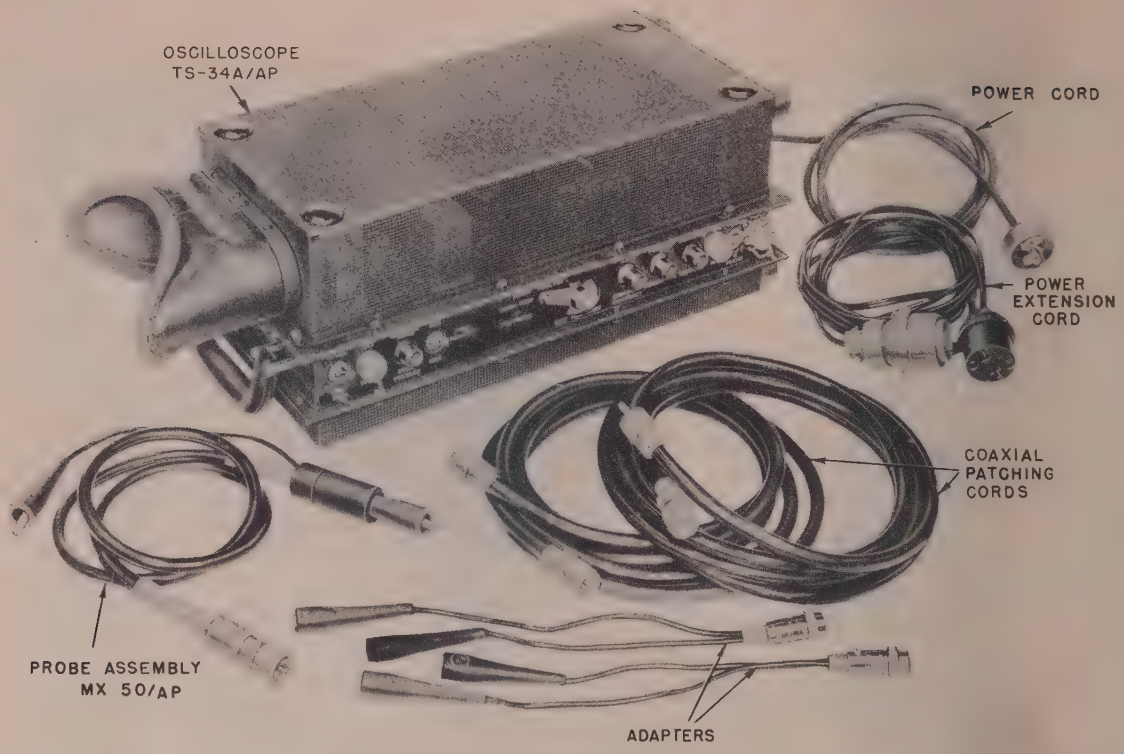


Figure 1-2. Oscilloscope TS-34A/AP
Equipment Required but Not Supplied

Quan. Per Equipment	*Name of Unit*	*Army-Navy Type Designation*	*Required Characteristics*
1	Directional Coupler (Wave Selector)	CU-206/U or CG-176/AF	20 db (at 9300 mc) directional waveguide coupling, increases with frequency by 1/8 db per 100-mc change.
1	Oscilloscope	TS-34A/AP or TS-239/UP	Start-stop type sawtooth sweep triggered at radar recurrence frequency to produce A-scan. Equivalent to TS-34A/AP

4. PHYSICAL DESCRIPTION

a. Model 38A F-M TEST SET (figure 1-3).-The Test Set is completely enclosed on five sides by a removable dust cover and on the front by the control panel. The control panel is fitted with a protective cover which contains all the cables and accessories listed in paragraph 2. All controls, indicators, and cable connections are located on the front panel.

b. PICKUP HORN AT-68/UP (figure 1-4).-The pickup horn is a small, directive-antenna assembly which can be used both for receiving external r-f energy to be measured by the Test Set and for transmitting the r-f test signal generated in the Test Set. The horn consists of a tapered section of waveguide which is terminated by a probe coupling to a coaxial fitting. The horn is connected by means of the output cable assembly, CG-92A/U(8), to the receptacle marked "RF" on the Test-Set panel.

c. OUTPUT CABLE ASSEMBLY CG-92A/U(8) (figure 1-4).-This cable is used for making the r-f connection to the radar system under test. Either a directional coupler or a pickup horn is used to complete the r-f connection. The cable assembly consists of eight feet of RG-9/U cable fitted with two UG-21B/U connectors. Connection is made to the UG-23B/U receptacle marked "RF" on the control panel. (See figures 2-2 and 2-3). The value for the r-f attenuation of the cable, accurate to ±0.3 db at 8500,

9080 and 9600 mc, is stamped on a metal tag which is attached to each unit. The attenuation of the cable may change with time.

d. VIDEO CABLE ASSEMBLY CG-638/U(6) (figure 1-4).-This cable is used for connecting a trigger voltage to the Test Set when it is not possible to trigger the set by means of r-f pulses. The cable assembly consists of six feet of RG-11/U cable fitted with two Navy-type 49195 connectors. An accessory right-angle video connector, Navy-type 49192A, is coupled to one of the cable fittings. The video cable connects to the receptacle marked "EXT MOD-TRIGGER IN" on the control panel.

e. POWER CORD ASSEMBLY CX-337/U(6) (figure 1-4).-Connection of the Test Set to a 115-volt, a-c power source is made by this cord. The assembly consists of six feet of rubber covered two-conductor cord provided with a female and a male fitting. The female fitting connects to the recessed plug marked "115V AC" on the control panel. The male plug will fit a standard two-prong flush-base receptacle.

f. ADAPTER UG-255/U (figure 1-4).-This BNC-to-UHF adapter is used to connect video cable CG-638/U(6) to female BNC fittings.

g. OPERATING SPARES (figures 1-4 and 4-4).-The following operating spares are supplied to replace corresponding parts in the Test Set:

(1) THERMISTOR MOUNT.-One complete spare thermistor mount is attached inside of the Test Set chassis (figure 4-4). Details on replacement are contained in Paragraph IV.3.*c.*

(2) FUSES.-Five two-ampere type 3AG cartridge fuses. Two are mounted in the holders marked "SPARES" on the control panel; and three are contained inside the cover.

(3) GASKETS.-Nine gaskets used in waveguide flange joints. (See figure 3-4.)

(4) LAMPS.-Three 3.0-volt panel lamps.

(5) CRYSTALS.-Two Navy-type 1N23B silicon rectifier crystals to replace the crystal in the r-f output and detector section.

5. ELECTRICAL DESCRIPTION.

a. The Test Set is a microwave signal generator which supplies frequency-modulated and c-w test signals, and measures microwave power and frequency.

b. The signal generator consists essentially of a reflex-klystron oscillator (723A/B or 2K25) and a triggered sweep generator which can modulate the frequency of the klystron by applying a sawtooth voltage to the reflector of the tube. The sweep can be triggered either by r-f pulses applied to the RF receptacle or by voltage pulses applied to the EXT MOD-TRIGGER IN receptacle of the Test Set.

c. Frequency-modulated pulses are produced by an internal sawtooth sweep which can be varied to produce frequency excursions from zero (cw) to at least 60 mc by changing the sweep amplitude. At maximum amplitude the sweep voltage covers three modes of the klystron. On the A-scope each mode covered appears as a sharp pip. The pips can be widened into broad response curves by decreasing the sweep amplitude. Changing the d-c level of the sweep changes the position of the test signals along the range axis of the A-scope. Test signals can be seen on all types of radar indicators as artificial signals.

d. Measurements of average microwave power are made by a temperature-compensated thermistor-bridge wattmeter and a calibrated r-f attenuator. The Test Set can measure both the power level of the test signals generated internally and the power level of external signals applied to it. Power is measured in dbm (decibels relative to one milliwatt) over a range of -42 to -85 dbm for peak levels of test signals supplied by the Set and +7 to +30 for average levels of external power applied to the Test Set. These measurements are accurate within 1.5 db. These power ranges give the levels at the RF input-output receptacle on the Test Set and, in operation, the attenuation of any cables or coupling devices used must be added to the stated levels.

e. Frequency measurements are made by an absorption-type cavity frequency meter which uses the thermistor bridge wattmeter as a tuning indicator. The frequency meter, when tuned to resonance, causes sufficient mismatch in the waveguide to reflect part of the incident power traveling toward the thermistor mount. Therefore a dip in the wattmeter indication

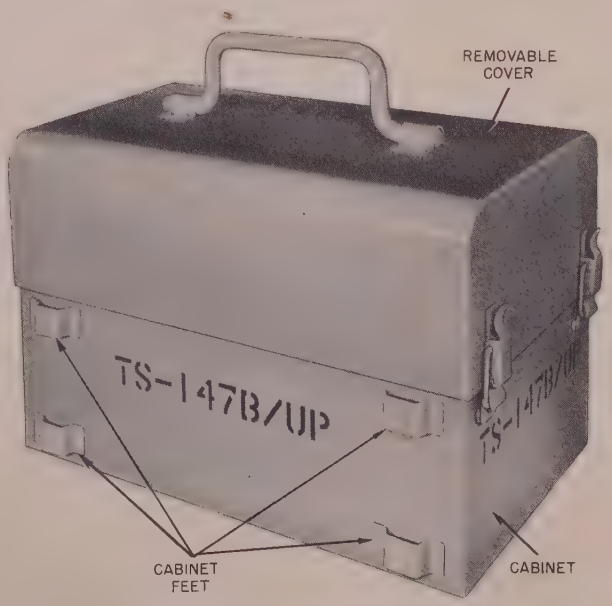
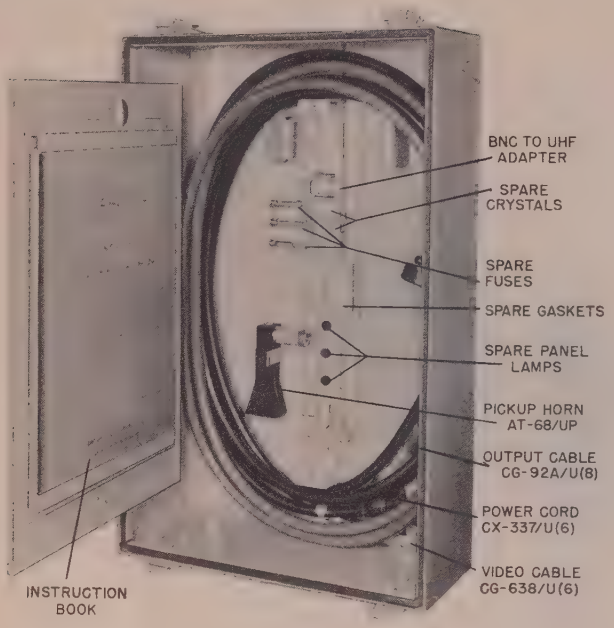


Figure I-3. The Test Set Stowed for Carrying



NOTE

With the exception of the cables, the accessories and operating spares for all Test Sets after Serial No. C-50 will be packaged within a small compartment in the cover of each unit.

Figure I-4. Test-Set Accessories

is observed. The range of the frequency meter is 8500 to 9600 mc. It is accurate to within 2.5 mc over this range. The frequency difference between any two signals not more than 60 mc apart can be measured to within 1.0 mc. The frequency meter is calibrated to within 1.0 mc at 9310 mc. The frequency meter can be used both for test signals generated within the Test Set and for external power applied to the instrument.

6. APPLICATIONS.

Applications of the Test Set include measurement of the radar transmitter power and frequency; waveshape pattern of transmitting tube; measurement of the radar receiver bandwidth, sensitivity, and recovery time; tuning of radar and beacon local oscillators; and performance tests of TR box, AFC system, and rotating joints. Usually only one connection is required between the Test Set and the radar system for all of the above applications (see paragraph II.6).

7. PERFORMANCE CHARACTERISTICS.

a. FREQUENCY METER.

(1) Range: 8500 mc to 9600 mc.

(2) Absolute Accuracy: ±2.5 mc at 25°C and 60% relative humidity.

(3) Relative Accuracy: ±1.0 mc for frequency increments of less than 60 mc.

(4) Calibration Point: 9310 ±1.0 mc at 25°C and 60% relative humidity.

NOTE

Accuracy can be greatly improved through use of temperature and humidity corrections described in paragraph V.6.

b. POWER METER. (See paragraph I.5.*d.*)

(1) Input Signals (average-power levels).

(a) Range: +7 to +30 dbm at RF receptacle.

(b) Accuracy: ±1.5 db.

(2) Output Test Signals (peak mode power).

(a) Range: -42 to -85 dbm at RF receptacle.

(b) Accuracy: ±1.5 db.

NOTE

Accuracy of power measurements depends upon calibration of directional coupler and r-f cable losses. Attenuation of cables can be checked by the procedure described in paragraph V.2. The stated tolerances assume use of the calibration chart mounted on panel of the Test Set. See figure 1-5.

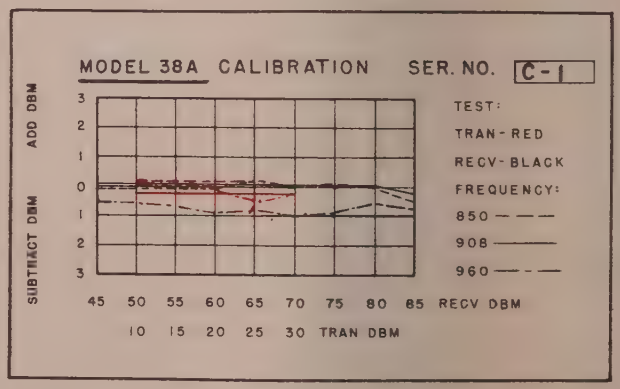


Figure I-5. Typical Calibration Chart

c. SIGNAL GENERATOR.

(1) Tuning Range: 8500 mc to 9600 mc, provided a suitable oscillator tube is used.

(2) Power Output: As specified in 7.*b.*(2)(a).

(3) Frequency Modulation.

(a) Sweep Rate: Zero to 6 mc/μs for oscillator tubes having at least 3 mc/volt tuning range.

(b) Center Frequency Range: As specified in 7.c.(1).

(c) Phase Range: 3 to 50μs after trigger.

(d) Frequency Excursion of Sweep: Zero to over 60 mc.

(e) With suitable oscillator tubes, the reflector voltage sweep can cover three modes.

(f) Triggers Required for Sawtooth Sweep Generator:

1. R-f Trigger: 5 to 500-watts peak, pulse repetition rates up to 4000, 0.2 to 6 μs duration, time-of-rise of 0.5 μs.

2. Video Trigger: Positive polarity, 10 to 50 volts peak, 0.5 to 20μs duration at 50% max. amplitude, less than 0.5μs time-of-rise between 90% and 10% max. amplitude points; flat between 90% peak amplitude of initial rise and 90% of peak amplitude of final decay. Amplitude varies between 90% and 100% of peak amplitude of initial rise; voltage rise in final decay less than 10% of peak amplitude.

d. POWER REQUIREMENTS.

(1) Voltage: 115 volts ±10%.

(2) Frequency: 50 to 1600 cycles.

(3) Power: less than 125 watts.

e. POWER-SUPPLY VOLTAGES.

(1) Plate Supply: +300 volts, electronically regulated.

(2) Reflector Supply: -210 volts, gas-tube regulation.

(3) Ripple: less than 0.1% peak of d-c level.

f. SAWTOOTH SWEEP.

(1) Amplitude: 0 to -100 volts (negative polarity).

(2) Max. Deviation from linearity: 10% of sweep amplitude.

(3) Slope: 0 to +2.0 volts/μs (positive slope).

(4) D-c Level at Oscillator Reflector: -60 to -210 volts.

(5) Video Amplifier Gain: Approx. 500.

g. TUBE AND CRYSTAL COMPLEMENT.

2-0B2	V-R tube (V105, V106)
1-1N23B	Silicon rectifier crystal (CR101)
1-5R4-GY	Full-wave rectifier (V101)
2-6SL7-GT	Twin triode (V107, V108)
1-6SH7	Pentode regulator amplifier (V103)
1-6Y6-G	Beam power regulator control (V102)
1-723A/B or 2K25	Microwave oscillator (V104)

Figure 2-1. Model 38A F-M Test Set
Control Panel

SECTION II

OPERATION AND ADJUSTMENT

1. GENERAL.

This section describes the installation, operation, and application of the Test Set. The material under APPLICATIONS illustrates specific uses of the Test Set in testing various radar systems. For detailed explanation of the principles of operation, see Section III.

2. INSTALLATION AND ADJUSTMENT.

a. The Test Set is a portable instrument which requires no installation or special adjustments before it is connected to a power source and put into operation. The sole requirements for best operation of the Test Set are:

(1) When making connections, the operator should arrange the equipment so that it is possible to operate the Test Set controls and observe the patterns on the oscilloscope screen while making adjustments on the radar system.

(2) The power source must be able to furnish at least 125 watts of power at 115v ±10%, 50 to 1600 cycles.

CAUTION

SET THE DBM ATTENUATOR TO MAXIMUM ATTENUATION BEFORE CONNECTING THE POWER CORD AND TURNING ON THE TEST SET.

b. Refer to figure 7-4 for cable information.

3. PERFORMANCE TEST.

When necessary, the following performance check can be used to ascertain whether or not the equipment is in operating condition before being issued to operating personnel:

a. Take off cover of Test Set and remove chassis from case. The chassis is retained in the case by the four fasteners on the control panel. See screws marked A in figures 4-1, 4-2, and 4-3.

b. Inspect the Test Set chassis for damaged tubes and components. Make certain that no tubes are missing and that all tubes are properly mounted in their designated sockets.

c. Remove cover to tube-mount assembly (figure 3-7) and inspect the oscillator tube, V104 (723A/B or 2K25). Make certain that the tube is inserted all the way into the socket and that the tube cap is connected. Turn the SIGNAL FREQ. shaft to see that the coupling end turns the tuning nut on the oscillator tube.

d. Examine the bridge meter for damage. If the pointer stands deflected from the zero line, replace the unit with a meter whose pointer is properly set.

e. Connect the Test Set to a 115v (50 to 1600 cycle) power source.

f. Place ON-OFF switch to ON position and allow approximately one or two minutes for the Test Set to warm up.

g. During warm-up time the dial lamps for the DBM and FREQUENCY dials should light. Also tubes V105 and V106 (figure 4-1) should glow steadily and the pointer of the bridge meter should deflect to the left of the zero point.

h. After warm-up is complete, turn the TEST knob to TRAN and adjust the FINE METER BALANCE knob until the meter reads zero. If this adjustment cannot be made properly, then adjust the METER BALANCE COARSE control according to the instructions in paragraph IV.5.

i. Make the following control settings:

Control	*Setting*
SIGNAL WIDTH	Full clockwise (CW)
PHASE	Full counterclockwise (MIN)
TEST	RECV
POWER SET	Full counterclockwise
SIGNAL FREQ.	Middle of range
INT-FM EXT MOD	INT-FM

j. Turn the PHASE control slowly clockwise until the meter pointer deflects to the right from zero. This indicates that the oscillator tube is oscillating. Now adjust the PHASE control for maximum deflection, and turn the POWER SET knob clockwise to limit the pointer deflection to mid-scale of the meter.

k. Continue to turn the PHASE control *slowly* clockwise until the pointer drops back to zero position and then deflects again towards mid-scale. There should be at least three separate positions of the PHASE control where the pointer deflects to indicate oscillation.

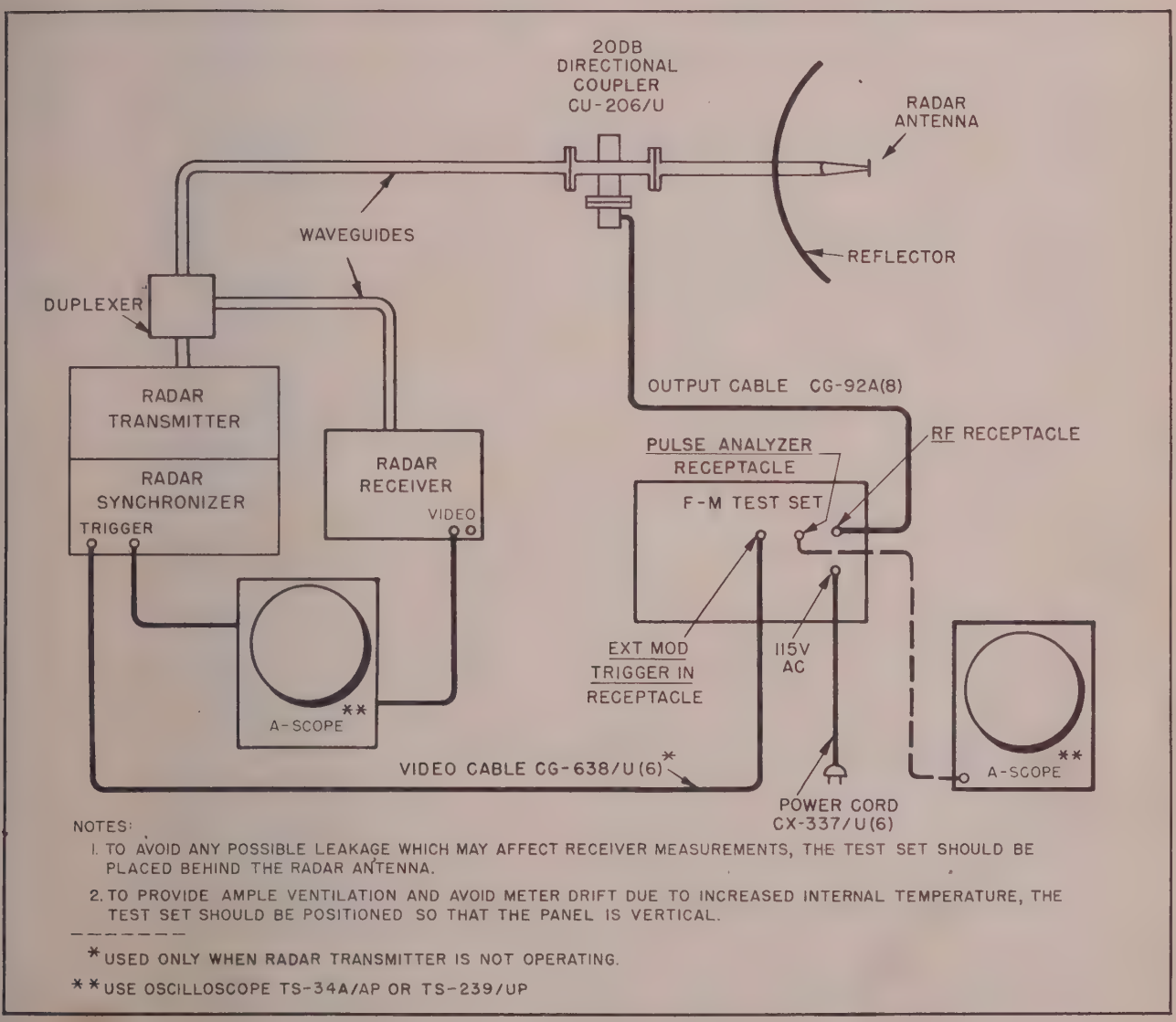
l. Adjust the PHASE control for the peak of the largest of the several deflections. Adjust the POWER SET knob to set the meter pointer to the highest on-scale reading that is practical to use. Turn the FREQUENCY knob fully counterclockwise.

m. Very slowly turn the FINE FREQUENCY knob clockwise until a dip is produced in the meter deflection. This dip is very sharp, and the adjustment to obtain it must be performed carefully.

n. If the Test Set passes these performance tests satisfactorily, replace the chassis within the case and secure it with the four fasteners.

4. PANEL CONTROLS.

Name	*Adjustment*	*Function*
ON-OFF (toggle switch)	ON	Applies 115v a-c power to power transformer to start Test Set. Turns Set heater off.
	OFF	Turns Test Set off. Turns Set heater on.
FINE METER BALANCE (potentiometer)	Adjust to balance meter.	Adjusts current through thermistor to set bridge meter reading to zero. DBM dial must be set to maximum attenuation and TEST knob must be set to TRAN when this adjustment is made.
DBM (calibrated output attenuator)	Adjust for 1.0 milliwatt reading on meter. Read +7 to +30 dbm scale.	Measures average level of transmitter power in decibels above one milliwatt. (TEST knob must be set to TRAN position.)
	Adjust for 1.0 milliwatt reading on meter. Read -42 to -85 on dbm scale.	Measures peak power level of test signal output in decibels below one milliwatt. (TEST knob must be set to RECV position.)
TEST (function selector)	TRAN	Sets range of DBM for transmitter power measurements (+7 to +30 dbm scale). Cuts off test signal.
	(DOT) "TEST" position.	Turns on test signal. Sets range of DBM for high-level test signal outputs.
	RECV	Turns on test signal and sets range of DBM for measuring power of low-level test signal output for receiver testing. (-42 to -85 dbm scale.)
FREQUENCY (absorption frequency meter)	Tune to dip in bridge meter reading.	Tunes frequency meter to resonance at frequency being measured. Multiply dial reading by 10 to obtain frequency in megacycles.
PHASE (potentiometer)	Any position.	Controls d-c reflector voltage on test oscillator tube. For c-w operation: selects operating mode for test oscillator. For f-m operation: adjusts time delay between trigger and center frequency of test signal. Shifts position of response curve along horizontal axis of oscilloscope.
POWER SET (test signal attenuator)	Adjust for 1.0 milliwatt reading on meter.	Adjusts initial power level of test signal to unbalance bridge by 1.0 milliwatt.
SIGNAL FREQ. (test oscillator tuning)	Any position.	Tunes test signal to desired frequency.
SIGNAL WIDTH (potentiometer)	Any position.	Controls rate and deviation of test signal frequency modulation. Controls width of pattern on oscilloscope.
INT-FM EXT MOD (trigger switch)	INT-FM	Connects EXT MOD-TRIGGER IN receptacle for external pulsing of sawtooth generator in the Test Set.
	EXT-MOD	Connects EXT MOD-TRIGGER IN receptacle for external modulation of test oscillator.
MOD AMP (potentiometer)	Any position.	Controls amplitude of externally modulated signals applied to EXT MOD-TRIGGER IN receptacle.



NOTES:

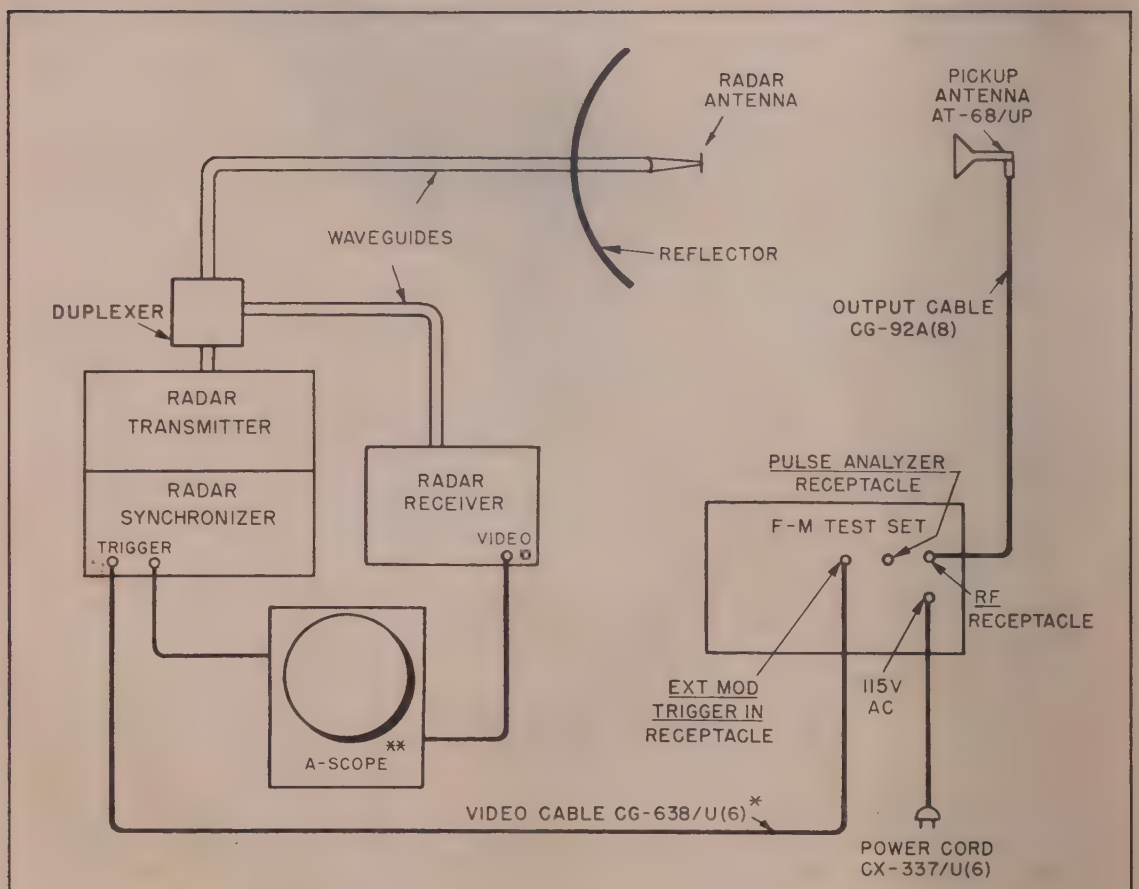
1. TO AVOID ANY POSSIBLE LEAKAGE WHICH MAY AFFECT RECEIVER MEASUREMENTS, THE TEST SET SHOULD BE PLACED BEHIND THE RADAR ANTENNA.
2. TO PROVIDE AMPLE VENTILATION AND AVOID METER DRIFT DUE TO INCREASED INTERNAL TEMPERATURE, THE TEST SET SHOULD BE POSITIONED SO THAT THE PANEL IS VERTICAL.

---

*USED ONLY WHEN RADAR TRANSMITTER IS NOT OPERATING.

**USE OSCILLOSCOPE TS-34A/AP OR TS-239/UP

Figure 2-2. Complete Connections Using 20-DB Directional Coupler CU-206/U



NOTES:

1. TO AVOID ANY POSSIBLE LEAKAGE WHICH MAY AFFECT RECEIVER MEASUREMENTS, THE TEST SET SHOULD BE PLACED BEHIND THE RADAR ANTENNA.
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*USED ONLY WHEN RADAR TRANSMITTER IS NOT OPERATING.

**USE OSCILLOSCOPE TS-34A/AP OR TS-239/UP

Figure 2-3. Complete Connections Using Pickup Antenna AT-68/UP

5. CONNECTIONS.

a. Use of the Test Set in the full scope of its applications requires four connections:

(1) Power must be supplied to operate the Test Set. For this connection use Power Cord CX-337/U(6) connected to the 115V AC receptacle on the Test Set panel. The Test Set operates on 115 volts (±10%), 50- to 1600-cycle power.

(2) R-f coupling must be made between the Test Set and the radar system. For this connection use Output Cable CG-92A/U connected to the RF receptacle on the Test Set panel. Either Pickup Horn AT-68/UP or a 20-db directional coupler can be used to couple the cable to the radar system.

(3) Trigger for the Test Set sweep generator is required when the f-m test signals are to be used. A trigger is supplied by the r-f pulses applied to the RF receptacle without any additional connections or by any standard video trigger, such as IFF trigger, applied to the EXT MOD-TRIGGER IN receptacle (with trigger switch on INT-FM) by means of the Video Cable CG-638/U(6).

(4) An Oscilloscope (TS-34A/AP or TS-239/AP) connected to the video output of the radar receiver is used to indicate the response of the system by A-scan.

b. The first two connections, (1) and (2), are always required; connection (3) is necessary for tests on radar receivers. Complete connections are shown in figures 2-2 and 2-3.

NOTE

For many tests, the radar system indicator is satisfactory in place of the separate A-scope. An A-scope *is* necessary, however, for measuring receiver bandwidth and recovery time.

6. APPLICATIONS: RADAR PERFORMANCE TESTS.

NOTE

Each primary subdivision of this paragraph, i.e., 6*a*. 6*b*. 6*c*. etc. is complete in itself or contains all necessary references to previous tests. For an abridged procedure in which each primary subdivision is dependent upon the preceding, use paragraph 7, which is intended for use in making a quick but complete performance test in connection with Radar Performance Data Sheets. (See sample in figure 2-12.)

a. PRELIMINARY PROCEDURE.

(1) PREPARE RADAR.- Turn radar on, observe modulator current, rectifier current, and crystal current. Leave radar spinner stationary.

(2) Prepare the Test Set.

(a) SET CONTROLS:

Control	*Setting*
TEST	TRAN
DBM	All the way counter-clockwise.

(b) CONNECT TEST SET.- Make power, r-f, and trigger (if needed) connections specified in paragraph 5.

(3) PREPARE OSCILLOSCOPE (not used if radar has A or J-Scope).- Use TS-34A/AP, TS-239/AP or equivalent oscilloscope with sweep length of 50 to 100 microseconds.

(a) TS-34A/AP.- Turn POWER ON; set to NORMAL; SWEEP SELECTOR to START-STOP; SWEEP SPEED to MED; INPUT IMPEDANCE to HIGH; ATTENUATION to 20 db. Switch to EXT SYNC and connect radar trigger to EXT SYNC (or use INT SYNC). Connect radar video signal to SIGNAL INPUT (TS-34A/AP). Adjust INPUT IMPEDANCE and ATTENUATION for convenient signal height. Adjust SYNC VOLTAGE for steady signals (check SYNC POLARITY).

(b) TS-239/AP.- Set controls to equivalent settings as specified in (a) above.

b. MEASURING TRANSMITTER AVERAGE POWER (P_{av}).

(1) CONNECT TEST SET TO RADAR.- Connect Output Cable CG-92A/U from RF receptacle to radar directional coupler (or test horn) as in figure 2-2 (or 2-3). Set TEST knob to TRAN and set DBM knob all the way counter-clockwise.

(2) TURN ON TEST SET.- Connect 115V AC receptacle to power line with Power Cord CX-377/U. Turn 115V AC switch to ON and wait two minutes.

(3) BALANCE METER.- With TEST to TRAN and DBM full counter-clockwise, adjust FINE METER BALANCE control until meter reads zero.

(4) SET POWER.- Turn DBM dial clockwise, reducing attenuation until meter pointer is below 1.0 milliwatt. Detune FREQUENCY meter. Set meter to 1.0 milliwatt by turning DBM dial counter-clockwise. Read DBM dial and record.

(5) COMPUTE TRANSMITTER AVERAGE POWER (P_{av}).- Compute as follows:

$$P_{av(dbm)} = +T^{1}_{(dbm)} + A_{(db)} + C_{(db)}.$$

$P_{av(dbm)}$ = Transmitter Average Power (in decibels above one milliwatt).

$T^{1}_{(dbm)}$ = Average r-f power entering the Test Set (in dbm). Reading of DBM dial in step (4).

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between Test Set and directional coupler (or horn) in decibels. See paragraph V.2. for r-f cable calibration.

$C_{(db)}$ = Coupling of directional coupler in decibels (or space loss between radar antenna and horn).

(6) COMPARE WITH RATED P_{av}.-Compare the measured value of transmitter average power (P_{av}) with the rated value. If the rated value is not given in dbm, convert to dbm by use of figure 2-8. If the rated peak power is known, compute rated average power by procedure of paragraph 6.*g*.(2).

c. MEASURING TRANSMITTER FREQUENCY (f_t).

(1) OBTAIN POWER INDICATION.-Perform the following operations, unless already completed:

Operation	*Paragraph*
Connect Test Set to Radar.....	6.*b*.(1)
Turn on Test Set.....	6.*b*.(2)
Balance Meter.....	6.*b*.(3)
Set Power.....	6.*b*.(4)

(2) OBSERVE FREQUENCY.-Tune FREQUENCY knob for dip in meter reading. Carefully set to maximum dip, turning FREQUENCY knob counter-clockwise to avoid backlash. Record reading and multiply by ten to convert to megacycles.

CAUTION

A SECONDARY MODE IS PRESENT AT ABOUT HALF THE DIAL FROM THE PRIMARY MODE IN THE FREQUENCY METER CHARACTERISTIC. THE SECONDARY MODE GIVES A MUCH SMALLER DIP AND IS APPROXIMATELY FOUR TIMES AS WIDE. IT SHOULD BE AVOIDED WHEN MEASURING FREQUENCIES NEAR THE LIMITS OF THE FREQUENCY-METER RANGE.

d. MEASURING RECEIVER FREQUENCY.

(1) PREPARE RADAR, TEST SET, AND OSCILLOSCOPE.-Perform the following operations, unless already completed.

Operation	*Paragraph*
Prepare Radar.....	6.*a*.(1)
Prepare Test Set.....	6.*a*(2)
Prepare Oscilloscope.....	6.*a*.(3)

(2) ADJUST RADAR RECEIVER.-Leave Automatic Frequency Control on (if operative), set gain to show small amount of noise on A-Scope and J-Scope.

(3) TUNE TEST SET TO RECEIVER.

(a) SET TEST SET FOR TUNING.-Set TEST knob to TEST (dot) position between TRAN and RCVR; DBM knob to about +15 dbm; POWER SET knob near maximum (clockwise); PHASE knob near mid position.

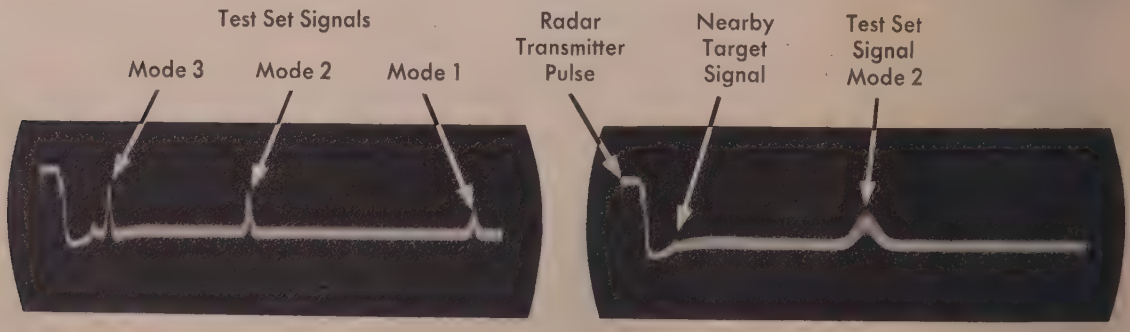
(b) OBTAIN F-M SIGNAL.-Set SIGNAL WIDTH knob to MIN. Adjust SIGNAL FREQ. knob for maximum signal; set TEST knob to RCVR and adjust DBM knob to prevent saturation (see figure 2-4A). Proceed to step (5) unless no signal is obtained over the SIGNAL FREQ. range.

(4) TUNE RECEIVER (if no test signals are apparent and Test Set is known to be operating properly).-Maximize crystal current with local-oscillator manual reflector voltage control. Adjust coupling, if necessary, to obtain crystal current. Tune for maximum target signals or echo-box signal and simultaneous maximum crystal current with local-oscillator mechanical tuning. Readjust reflector voltage when necessary to obtain crystal current. Then tune Test Set to receiver as in step (3). If no target signals can be observed, tune receiver with Test Set. See paragraph 6.*k* page 2-12 (or use an echo box).

(5) MEASURE f_r.

(a) OBTAIN BANDPASS CURVE.-Turn SIGNAL WIDTH knob toward center to obtain bandpass curve. Adjust PHASE knob to hold pattern on oscilloscope screen. (See figure 2-4B.)

(b) OBSERVE FREQUENCY.-Adjust FINE FREQUENCY control so that pip is on top of bandpass curve. (See figure 2-5A.) Record reading and multiply by ten. If f_r differs from f_t (or beacon), by twice the radar intermediate frequency, repeat paragraph 6.*d*.(3) and select the alternative signal (clockwise rotation of SIGNAL FREQ. decreases frequency). If the frequency differs from transmitter



A—Narrow FM Signals, SIGNAL WIDTH at MIN.

B—Bandpass Curve, SIGNAL WIDTH near Center of Range

Figure 2-4. Frequency Modulated Test-Set Signals

(or beacon) frequency by other than twice intermediate frequency, it would indicate AFC troubles. Look for defects in the following:

1. L-O Tuning (see 6.*k.*).
2. Discriminator tuning.
3. AFC circuit.
4. Shock excitation of first i-f stage (AFC).
5. Bad spectrum.

e. MEASURING BANDWIDTH.

(1) OBTAIN BANDPASS CURVE.- Perform the following operations, unless already completed:

Operation	*Paragraph*
Prepare Radar, Test Set, and Oscilloscope	6.*d.*(1)
Adjust Radar Receiver	6.*d.*(2)
Tune Test Set to Receiver	6.*d.*(3)
Tune Receiver (when necessary)	6.*d.*(4)
Measure Receiver Frequency	6.*d.*(5)

(2) MEASURE BANDWIDTH.- (See figure 2-5.)

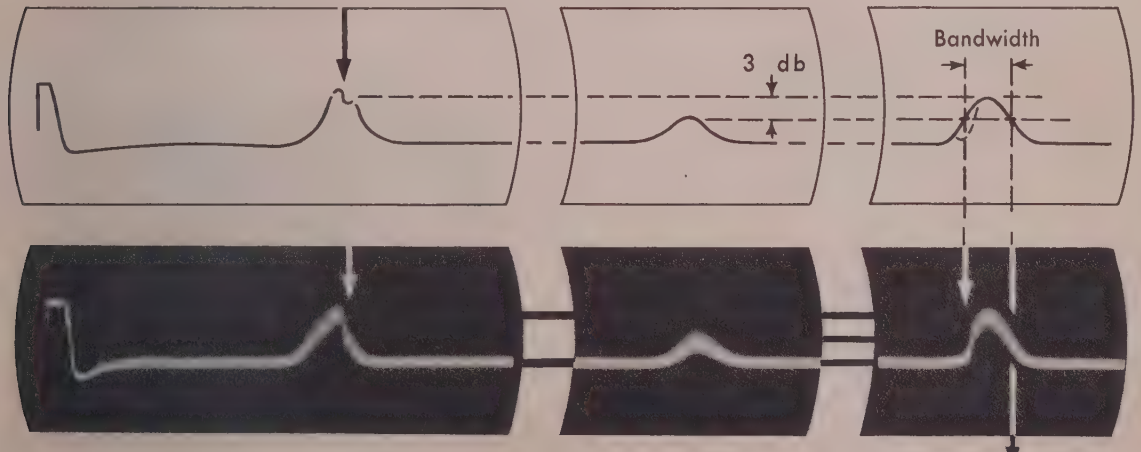
(a) OBTAIN HALF-POWER HEIGHT.- Increase the setting of DBM attenuator by 3.0 db; detune FREQUENCY meter; and mark half-power height. Restore DBM to original setting.

(b) MEASURE FREQUENCY DIFFERENCE.- Move the FREQUENCY meter pip across the curve, observing the readings at the two points where it goes through the half-power line determined in (a).

Bandwidth, $B = f_1 - f_2$.

NOTE

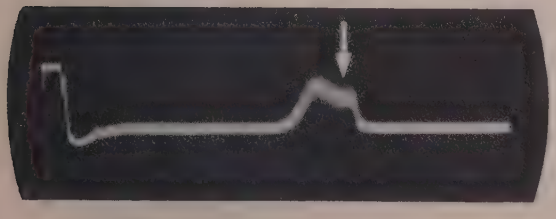
Sometimes when the frequency-meter pip is tuned within the passband, the response curve on the oscilloscope is so distorted that it is difficult to set the positions of frequency meter pip to the half-power points with sufficient accuracy. An alternative procedure, to be used when this condition occurs, is to calibrate the horizontal sweep in megacycles-per-inch and then measure the distance, and hence the frequency, between the two half-power points. The sweep calibration can be made by observing the distance the frequency-meter dip moves when tuned over a definite frequency range. This calibration is dependent on the



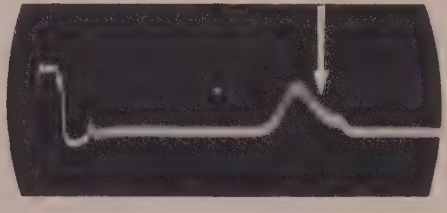
A—FREQUENCY Pip on Top of Bandpass Curve

B—FREQUENCY Meter Detuned, Signal Decreased by 3 db

C—Signal Height Restored, FREQUENCY Pip at Half Power Point (Left)



E—FREQUENCY Pip on Top of Curve, Showing Variation in Shape of Pip Under Different Conditions



D—FREQUENCY Pip at Half Power Point (Right)

Figure 2-5. Receiver Frequency and Bandwidth Measurements

setting of the SIGNAL WIDTH and PHASE knobs. Therefore, the setting of these knobs must not be changed after the calibration is made.

f. MEASURING RECEIVER PERFORMANCE FIGURE P_m (SENSITIVITY).- If the receiver is not known to be tuned to the transmitter, first check the receiver frequency by following paragraph 6.*d.*

(1) PREPARE RADAR, TEST SET, AND OSCILLOSCOPE.- Perform the following operations, unless already completed;

Operation	*Paragraph*
Prepare Radar.....	6.*a.*(1)
Prepare Test Set.....	6.*a.*(2)
Prepare Oscilloscope.....	6.*a.*(3)

(2) ADJUST RADAR RECEIVER.- Leave Automatic Frequency Control on (if operative). Set gain to show noise one-half of transmitter pulse or saturated signal amplitude.

(3) TUNE TEST SET TO RECEIVER.

(a) SET TEST SET FOR RCVR TEST.- Set TEST knob to RCVR; DBM knob to about +15 dbm; POWER SET knob near maximum (clockwise); PHASE knob near mid position.

(b) OBTAIN F-M SIGNAL.- Set SIGNAL WIDTH knob to MIN. Adjust SIGNAL FREQ. knob for maximum signal, adjusting DBM knob to prevent saturation (see figure 2-4A). If no Test Set signal can be obtained, set TEST knob to TEST position (dot) to deliver a higher level test signal to the receiver. If still no test signal is found, tune receiver by procedure of paragraph 6.*d.*(4).

(4) CHECK METER BALANCE.- Set TEST to TRAN; DBM full counter-clockwise. Then adjust FINE METER BALANCE control until meter reads zero.

(5) FIND SIGNAL AGAIN.- Set TEST to RECV, turn DBM clockwise to find f-m signal again.

(6) SET SIGNAL POWER ON C-W.- Broaden bandpass curve to maximum by turning SIGNAL WIDTH knob clockwise to CW, while holding pattern on screen with PHASE knob. Detune FREQUENCY meter. Adjust POWER SET knob so that meter reads 1.0 milliwatt.

(7) RETURN TO F-M SIGNAL.- Turn SIGNAL WIDTH carefully counter-clockwise to MIN, taking care to use same mode.

(8) DETERMINE MINIMUM DISCERNIBLE SIGNAL.- (see figure 2-6).- Turn DBM attenuator until signal just disappears in noise. When signal becomes as small as in part A of figure 2-6, turn the DBM knob in one-db steps, and move signal back and forth with PHASE knob for identification of signal. When the signal is last visible, read DBM dial.

(9) COMPUTE RECEIVER PERFORMANCE FIGURE:

$$P_{m(dbm)} = (-M_{(dbm)} - A_{(db)} - C_{(db)})$$

where:

$P_{m(dbm)}$ = Receiver performance figure in decibels below one milliwatt (-dbm). (Minimum discernible signal power converted to dbm.)

$M_{(dbm)}$ = Peak power output of the Test Set in dbm (DBM dial reading).

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between Test Set and directional coupler (or horn) in decibels.

$C_{(dbm)}$ = Coupling of directional coupler in decibels (or space loss between radar antenna and horn).

Example: See figure 2-12.

(10) COMPARE WITH RATED P_m.- Compare the measured value of Receiver Performance Figure, P_m, with the rated value. If the rated value is not given in dbm, convert to dbm by use of figure 2-8.

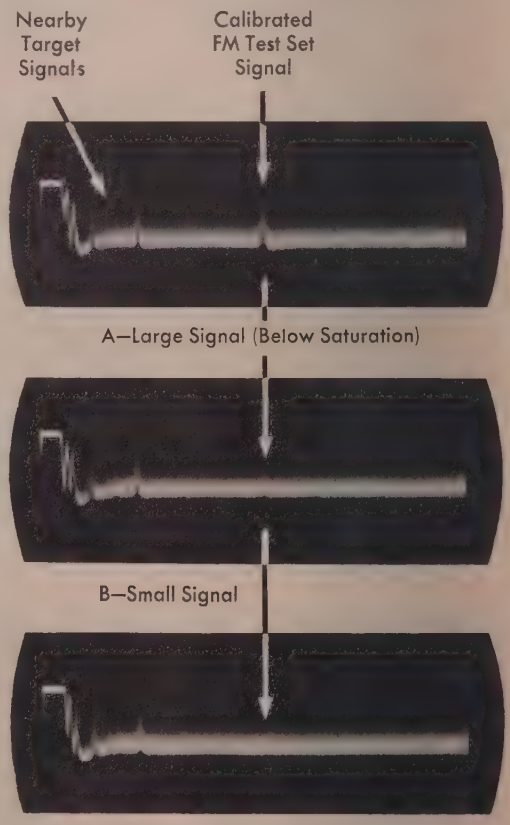


Figure 2-6. Measuring Minimum Discernible Signal Power

g. COMPUTING PERFORMANCE DATA.

(1) COMPUTING TRANSMITTER PERFORMANCE FIGURE.

(a) MEASURE TRANSMITTER AVERAGE POWER.- Follow procedure of paragraph 6.*b*.

(b) CONVERT TO TRANSMITTER PERFORMANCE FIGURE.-Compute as follows:

$$P_{pk(dbm)} = (P_{av(dbm)} + N_{(db)})$$

where:

$P_{pk(dbm)}$ = Transmitter performance figure in decibels above one milliwatt (+dbm) (transmitter peak power converted to dbm).

$P_{av(dbm)}$ = Transmitter average power in decibels above one milliwatt (+dbm).

$N_{(db)}$ = Number of decibels to be added to average power in dbm to convert to peak power in dbm (db due to duty cycle), (from figure 2-7).

Example:

$P_{av(dbm)}$ = 41.5 dbm.

pulse length = 1 microsecond.

pulse repetition rate = 650/sec.

From figure 2-7, $N_{(db)}$ = 31.5 db.

$P_{pk(dbm)}$ = 41.5 dbm + 31.5 db = +73 dbm.

(2) COMPUTING RATED TRANSMITTER AVERAGE POWER IN DBM.- If known in watts or kilowatts, convert to dbm by use of figure 2-8. If the rated peak power is known, proceed as follows:

(a) CONVERT RATED P_{pk} TO DBM.- Convert rated transmitter peak power from watts or kilowatts to dbm by use of figure 2-8. This figure is the rated transmitter performance figure, $P_{pk(dbm)}$.

(b) CONVERT RATED TRANSMITTER PERFORMANCE FIGURE TO RATED AVERAGE POWER.- Compute as follows:

$$P_{av(dbm)} = (P_{pk(dbm)} - N_{(db)}).$$

Example:

Rated P_{pk} = 40 kilowatts.

From figure 2-8, $P_{pk(dbm)}$ = +76 dbm.

For pulse length of 1 microsecond, pulse repetition rate of 650/sec, N = 31.5 db from figure 2-7.

Rated $P_{av(dbm)}$ = +76 -31.5 = +44.5 dbm.

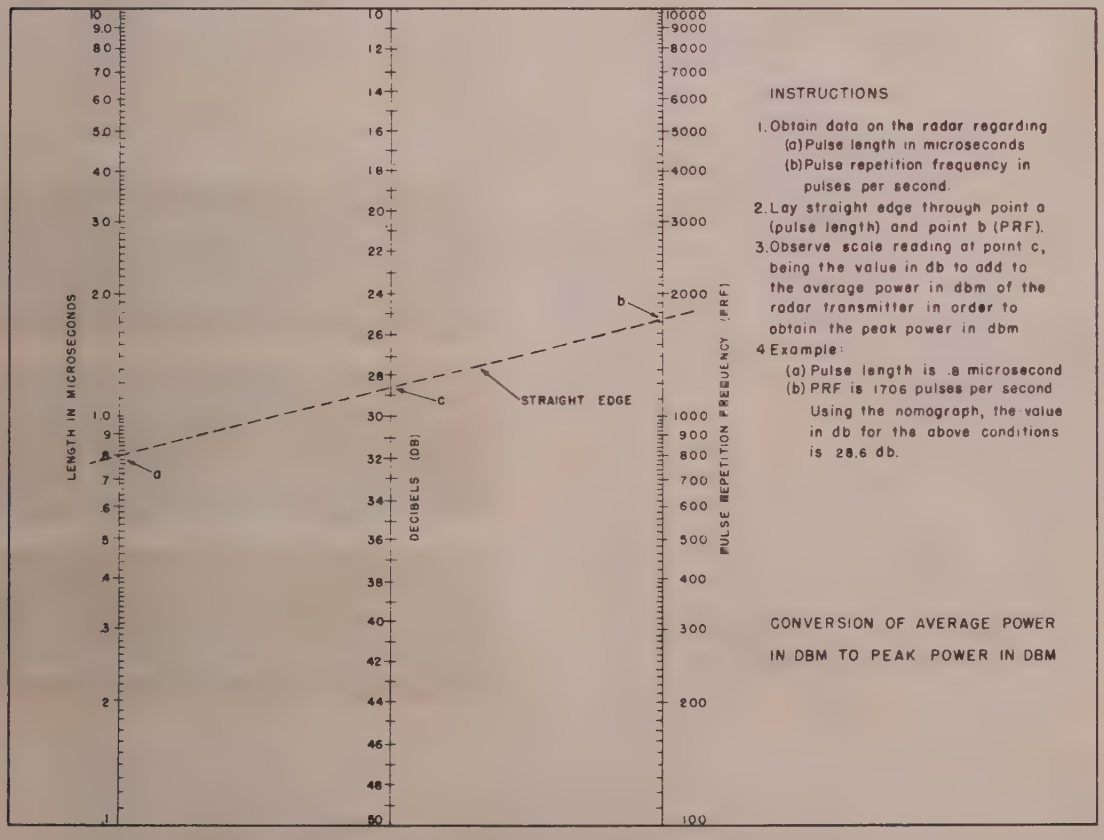

LENGTH IN MICROSECONDS
DECIBELS (DB)
PULSE REPETITION FREQUENCY (PRF)
STRAIGHT EDGE
a
b
c
INSTRUCTIONS
1. Obtain data on the radar regarding
(a) Pulse length in microseconds
(b) Pulse repetition frequency in pulses per second.
2. Lay straight edge through point a (pulse length) and point b (PRF).
3. Observe scale reading at point c, being the value in db to add to the average power in dbm of the radar transmitter in order to obtain the peak power in dbm
4 Example:
(a) Pulse length is .8 microsecond
(b) PRF is 1706 pulses per second
Using the nomograph, the value in db for the above conditions is 28.6 db.
CONVERSION OF AVERAGE POWER IN DBM TO PEAK POWER IN DBM

Figure 2-7. Average-to-Peak Power Conversion Chart

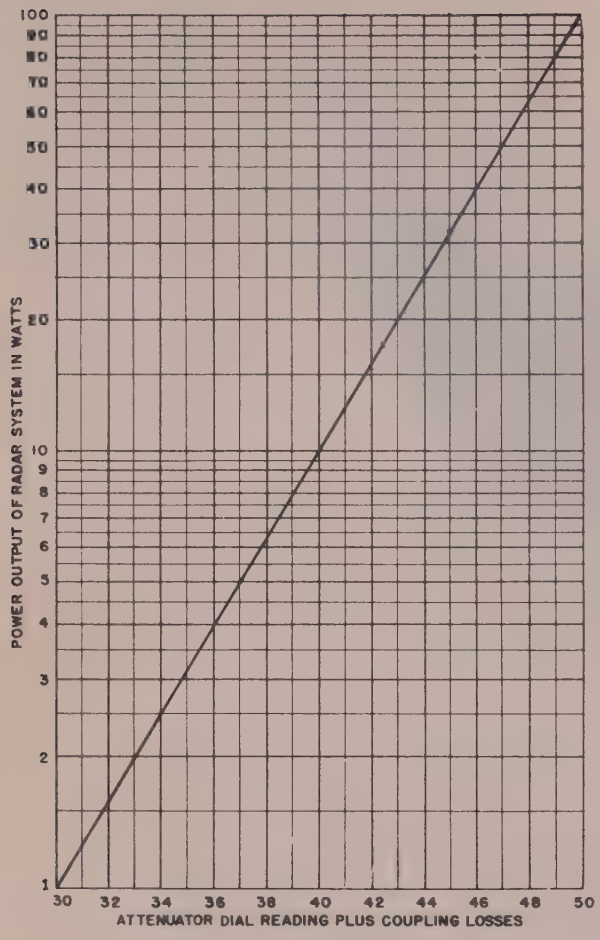


Figure 2-8. DBM-to-Watts Conversion Chart

(c) CHECKING FOR FREQUENCY SKIPPING AND DOUBLE MODING.- If the transmitter power level is low, make the following check for possible frequency skipping or double moding of the radar transmitter tube:

Connect video cable, CG-638/U(6), from the PULSE ANALYZER receptacle to the TS-34A/AP oscilloscope (or equivalent). Compare the observed waveshape patterns of the transmitter signal with that of figure 2-9A, showing the normal bandpass curve. Figure 2-9B gives evidence of frequency skipping, while double moding appears in figure 2-9c. Either of these latter conditions indicates the possibility of a faulty transmitter tube.

(3) COMPUTING OVERALL PERFORMANCE.

(a) DETERMINING RADAR PERFORMANCE FIGURE, S.-The radar performance figure, S, is a measure of the ability of a radar to detect small or distant targets. The effect of external factors such as atmospheric conditions, geometry of target, ground and water reflection is not included in this figure.

(1) Compute the radar performance figure from $P_{pk(dbm)}$ obtained in paragraph II.6.*g*.(1) and $P_{m(dbm)}$ obtained in paragraph II.6.*f*. as follows:

$$S_{(db)} = P_{pk(dbm)} - P_{m(dbm)}.$$

Example:

$P_{pk(dbm)}$ = +73 dbm.

$P_{m(dbm)}$ = -93 dbm.

$S_{(db)}$ = +73 dbm - (-93 dbm) = 166 db.

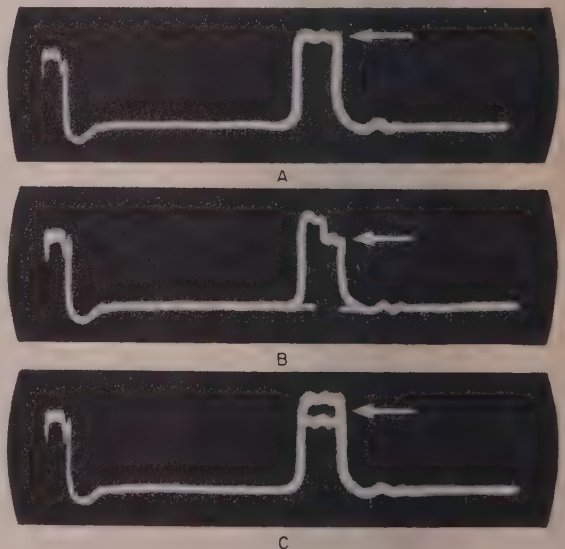
NOTE

When considering the ability of a radar to trigger a beacon and receiver, a beacon signal uses the transmitter performance figure $P_{pk(dbm)}$ and the receiver performance figure $P_{m(dbm)}$ separately, instead of combining them into the radar performance figure, S.

(2) Compare the radar performance figure $S_{(db)}$ with the expected performance figure. The expected figure can be obtained from the expected value of $P_{pk(dbm)}$ and $P_{m(dbm)}$ or the value obtained when the radar is known to be operating satisfactorily.

Example: If the expected radar performance figure $S_{(db)}$ = 171 db and the measured radar performance figure $S_{(db)}$ = 166 db, the radar performance is down 5 db.

(3) The effect on range can be obtained by reference to figure 2-10.



A - Normal Bandpass Curve
B - Frequency Skipping
C - Double Moding

Figure 2-9. Checking For Frequency Skipping and Double Moding

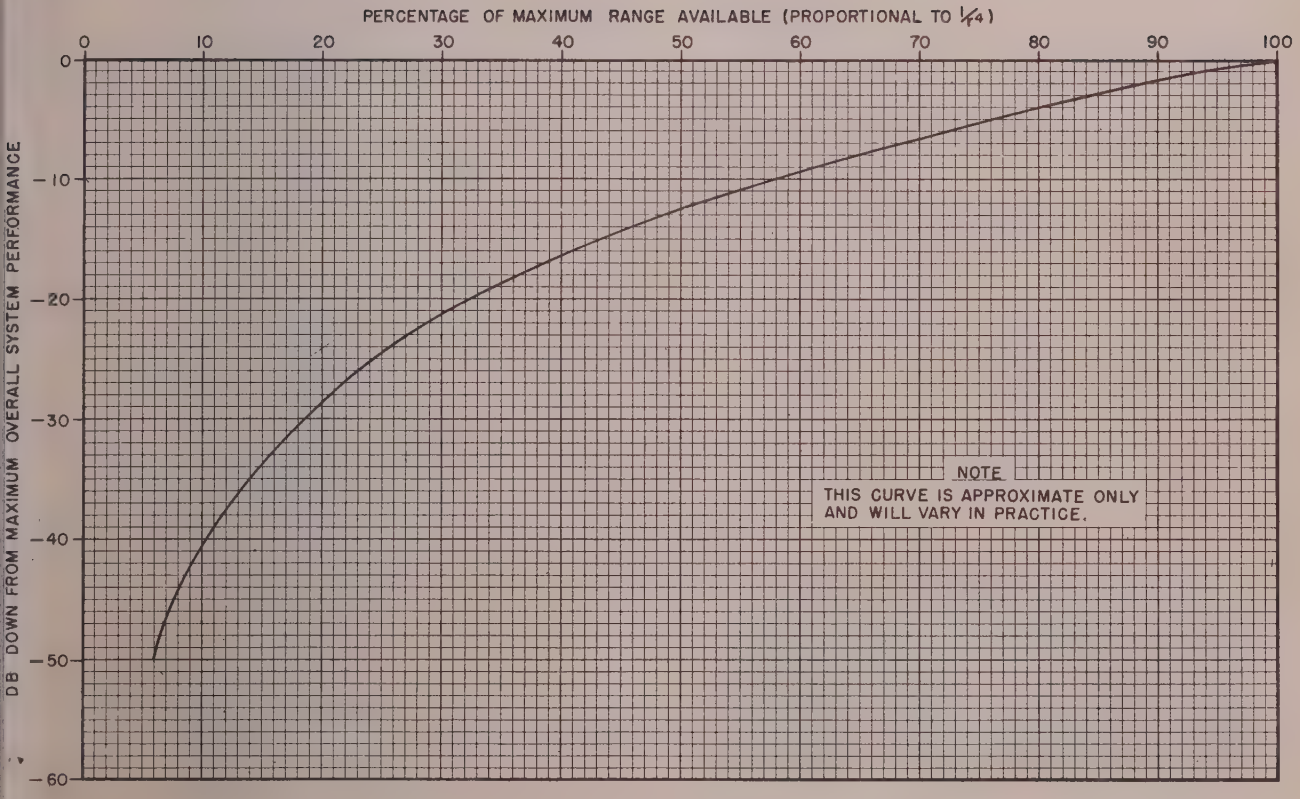


Figure 2-10. Radar Performance Versus Radar Range

NOTE

Where $P_{pk(dbm)}$ or $P_{av(dbm)}$ (when measured on BEACON) is down 2 db and $P_{m(dbm)}$ is down 1.5 db, the range at which the radar could trigger a beacon is down to 79 percent of normal range and the range at which the radar could receive a beacon signal is down 84 percent of normal range.

(b) COMPUTING CHANGE IN OVERALL PERFORMANCE.-For routine measurements time can be saved by adding the differences from rated transmitter average power obtained in paragraph 6.*b*.(6) and rated receiver performance figure obtained in paragraph 6.*f*.(10) to get change in radar performance figure as illustrated in figure 2-12, Sample Radar Performance Data Sheet.

h. MEASURING TR RECOVERY TIME.-There is an alternate method for measuring TR Recovery Time (or C-W). See paragraph V.4.

(1) OBTAIN F-M SIGNAL.-Perform the following operations, unless already completed:

Operation	*Paragraph*
Prepare Radar, Test Set and Oscilloscope	6.*d*.(1)
Adjust Radar Receiver	6.*d*.(2)
Tune Test Set to Receiver	6.*d*.(3)
Tune Receiver (if no test signals are obtained)	6.*d*.(4)

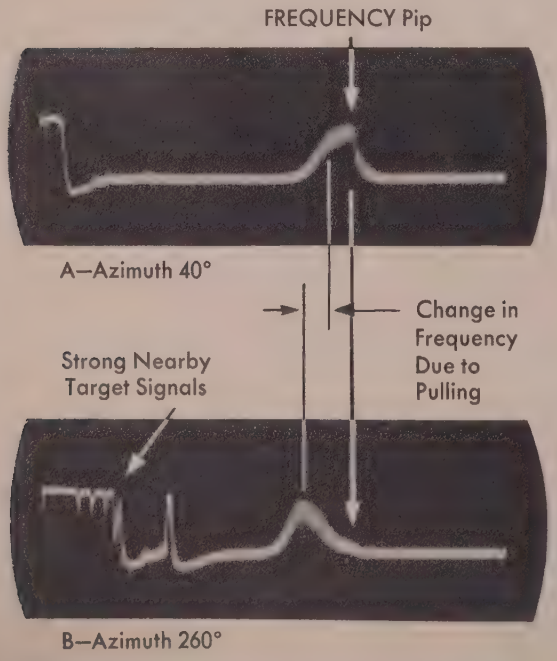


Figure 2-11. Checking Transmitter Pulling and AFC Tracking

(2) ADJUST SIGNAL HEIGHT.-Leave AFC on, if operative. Adjust gain for small amount of noise. Adjust DBM knob until signal height is about half way between noise and saturation.

(3) PHASE SIGNAL TOWARD TRANSMITTER PULSE.-Turn PHASE knob counter-clockwise toward MIN until signal height starts to decrease. Measure range from beginning of transmitter pulse to signal.

i. DETECTING TRANSMITTER PULLING AND CHECKING AFC TRACKING.

(1) OBTAIN F-M SIGNAL.-Perform the following operations, if not already completed:

Operation	*Paragraph*
Prepare Radar, Test Set, and Oscilloscope	6.*d*.(1)
Adjust Radar Receiver	6.*d*.(2)
Tune Test Set to Receiver	6.*d*.(3)
Tune Receiver (if no test signals are obtained)	6.*d*.(4)

(2) OBTAIN BANDPASS F-M SIGNAL.-Turn PHASE knob clockwise to put signal near center of screen. Broaden signal by turning SIGNAL WIDTH knob part way clockwise. Set FREQUENCY meter for pip on top of curve (f_1).

(3) CHECK FOR PULLING AND PROPER AFC TRACKING.-Start radar antenna spinner. If the f-m signal moves, there is probably pulling (see figure 2-11). If it remains on the screen, the AFC is tracking satisfactorily.

j. CHECKING BEACON RESPONSE OF RADAR.

(1) PRELIMINARY.-Switch radar to BEACON. Measure crystal current, rectifier current, and modulator current.

(2) MEASURE TRANSMITTER POWER.-Follow paragraph 6.*b*. (Most radars have different pulse length and repetition rate on Beacon).

(3) MEASURE TRANSMITTER FREQUENCY.-Follow paragraph 6.*c*.

(4) MEASURE RECEIVER FREQUENCY FOR BEACON RECEPTION.-Follow paragraph 6.*d*. substituting 9310 mc for transmitter frequency. First tune beacon receiver by procedure of paragraph 6.*k*. if there is no beacon AFC or tuning cavity.

(5) MEASURE RECEIVER PERFORMANCE FIGURE FOR BEACON RECEPTION.-Follow paragraph 6.*f*.

k. TUNING RADAR RECEIVERS. (For use when results are not satisfactory in paragraph 6.*d*. or when there is no AFC.):

(1) PREPARE RADAR, TEST SET, AND OSCILLOSCOPE.-Perform the following operations, unless already completed:

Operation	*Paragraph*
Prepare Radar.....	6.*a.*(1)
Prepare Test Set.....	6.*a.*(2)
Prepare Oscilloscope.....	6.*a.*(3)

(2) ADJUST RADAR RECEIVER.-Set radar on manual tuning. Set gain high enough to show small amount of noise on A or J-Scope

(3) SET TEST SET FOR RCVR TEST.-Set TEST knob to RCVR; DBM knob to about +50 dbm; POWER SET knob near maximum (clockwise); PHASE knob near mid position.

(4) TUNING RECEIVER TO TRANSMITTER (OR BEACON) FREQUENCY.-(To be used, if necessary, after paragraph 6.*d.*(4).):

(a) SET TEST SET ON CW.-Turn SIGNAL WIDTH knob clockwise to CW. Maximize meter reading with PHASE control. Leave TEST on RCVR; set DBM to about -50 dbm.

(b) SET TEST SET TO TRANSMITTER (OR BEACON) FREQUENCY.-Adjust SIGNAL FREQ. knob to transmitter (or beacon) frequency, resetting PHASE knob when meter drops ten percent, and checking frequency by dipping meter with FREQUENCY control.

(c) SET TEST SET ON FM.-Turn SIGNAL WIDTH knob to MIN. Set TEST knob to TEST (dot) position.

(d) DETUNE RECEIVER LOCAL OSCILLATOR.-Set radar on manual tuning. Set local oscillator at extreme end of tuning range, but on correct side of transmitter (or beacon) frequency. Adjust local oscillator for crystal current.

(e) TUNE RECEIVER TO TEST SET.-Slowly tune receiver local-oscillator mechanical tuning toward center of its range, resetting reflector voltage when crystal current drops. Watch for f-m signal on oscilloscope. Tune mechanical tuner of receiver for maximum f-m signal, and maximum crystal current. Set TEST knob to RCVR. Then, if necessary, adjust setting of DBM attenuator to prevent saturation.

(f) OBTAIN F-M BANDPASS CURVE.-Carefully broaden the SIGNAL WIDTH while holding the signal in view with the PHASE control until the bandpass curve is obtained. Adjust local oscillator to get FREQUENCY pip on top of curve.

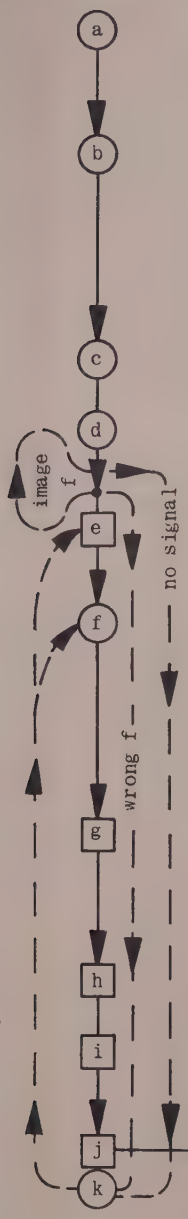
(4) ADJUST RADAR R-F COMPONENTS.-Tune TR and ATR for maximum Test Set signal. Adjust DBM attenuator to avoid saturated signal while tuning. Adjust crystal current for proper value. Readjust L-O, TR, and ATR to compensate for interaction.

(5) COMPARE AFC AND MANUAL.-Switch to AFC. If pattern moves more than a few megacycles, adjust AFC discriminator secondary. If pattern disappears on AFC, either the AFC is inoperative or the manual tuning is on the wrong side of the transmitter frequency.

DETACH HERE

RADAR PERFORMANCE DATA SHEET

Radar _____ Serial No. _____ F-M Test Set No. _____ Observer _____ Date _____



SEARCH

Preliminary Procedure

Radar Modulator Current..... _____ ma
Radar Rectifier Current..... _____ ma
Radar Crystal Current..... _____ ma

Transmitter Average Power

DBM Dial Reading..... _____ dbm
Cable Attenuation.....A _____ db
Coupling.....C _____ db
Total..... P_{av} _____ dbm
Rated..... _____ dbm
Difference..... _____ db

Transmitter Frequency

Reading _____ , Frequency..... f_t _____ mc

Receiver Frequency

Reading..... _____
Frequency..... f_r _____ mc

Receiver Bandwidth

Readings (1) _____ (2) _____
Bandwidth, f_1 _____ f_2 _____ B _____ mc

Receiver Performance Figure (Sensitivity)

DBM Dial Reading..... _____ dbm
Cable Attenuation.....-A _____ db
Coupling.....-C _____ db
Total..... P_m _____ dbm
Rated.....-(_____)dbm
Difference..... _____ db

Overall Performance

Differences _____ db..... _____ db
Overall Difference.....(b-f) _____ db
Transmitter Frequency Skipping....No☐ Yes☐
Double Moding.....No☐ Yes☐

TR Recovery

Range..... _____ miles

Transmitter Pulling; AFC Tracking

Transmitter Pulling: No☐ Yes☐
AFC Tracking.....Good☐ Poor☐

Beacon Response of Radar

Receiver Tuning

BEACON

j(1) **Preliminary**

_____ ma
_____ ma
_____ ma

j(2) **Trans. P_{av}**

_____ dbm
A _____ db
C _____ db
P_{av} _____ dbm
_____ dbm
_____ db

j(3) **f_t on Beacon**

f_t _____ mc

j(4) **f_r for Beacon**

_____
f_r _____ mc

j(5) **P_m for Beacon**

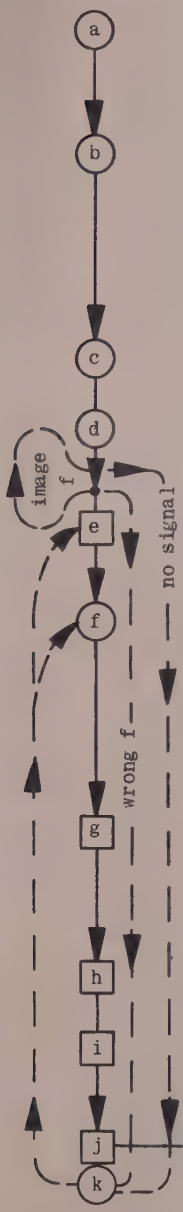
_____ dbm
-A _____ db
-C _____ db
P_m _____ dbm
-(_____) dbm
_____ db

Maintenance Notes:

DETACH HERE

RADAR PERFORMANCE DATA SHEET

Radar _____ Serial No. _____ F-M Test Set No. _____ Observer _____ Date _____



SEARCH

Preliminary Procedure

Radar Modulator Current..... _____ ma
Radar Rectifier Current..... _____ ma
Radar Crystal Current..... _____ ma

Transmitter Average Power

DBM Dial Reading..... _____ dbm
Cable Attenuation.....A _____ db
Coupling.....C _____ db
Total..... P_{av} _____ dbm
Rated..... _____ dbm
Difference..... _____ db

Transmitter Frequency

Reading _____ , Frequency..... f_t _____ mc

Receiver Frequency

Reading..... _____
Frequency..... f_r _____ mc

Receiver Bandwidth

Readings (1) _____ (2) _____
Bandwidth, f_1 _____ f_2 _____ B _____ mc

Receiver Performance Figure (Sensitivity)

DBM Dial Reading..... _____ dbm
Cable Attenuation.....-A _____ db
Coupling.....-C _____ db
Total..... P_m _____ dbm
Rated.....-(_____)dbm
Difference..... _____ db

Overall Performance

Differences _____ db..... _____ db
Overall Difference.....(b-f) _____ db
Transmitter Frequency Skipping....No ☐ Yes ☐
Double Moding.....No ☐ Yes ☐

TR Recovery

Range..... _____ miles

Transmitter Pulling; AFC Tracking

Transmitter Pulling: No ☐ Yes ☐
AFC Tracking.....Good ☐ Poor ☐

Beacon Response of Radar

Receiver Tuning

BEACON

j(1) **Preliminary**

_____ ma
_____ ma
_____ ma

j(2) **Trans. P_{av}**

_____ dbm
A _____ db
C _____ db
P_{av} _____ dbm
_____ dbm
_____ db

j(3) **f_t on Beacon**

f_t _____ mc

j(4) **f_r for Beacon**

_____
f_r _____ mc

j(5) **P_m for Beacon**

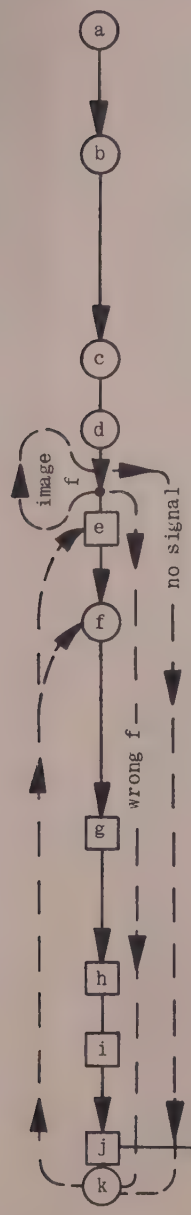
_____ dbm
-A _____ db
-C _____ db
P_m _____ dbm
-(_____) dbm
_____ db

Maintenance Notes:

DETACH HERE

RADAR PERFORMANCE DATA SHEET

Radar _____ Serial No. _____ F-M Test Set No. _____ Observer _____ Date _____



SEARCH

Preliminary Procedure

Radar Modulator Current..... _____ ma
Radar Rectifier Current..... _____ ma
Radar Crystal Current..... _____ ma

Transmitter Average Power

DBM Dial Reading..... _____ dbm
Cable Attenuation.....A _____ db
Coupling.....C _____ db
Total..... P_{av} _____ dbm
Rated..... _____ dbm
Difference..... _____ db

Transmitter Frequency

Reading _____ , Frequency..... f_t _____ mc

Receiver Frequency

Reading..... _____
Frequency..... f_r _____ mc

Receiver Bandwidth

Readings (1) _____ (2) _____
Bandwidth, f_1 _____ f_2 _____ B _____ mc

Receiver Performance Figure (Sensitivity)

DBM Dial Reading..... _____ dbm
Cable Attenuation.....-A _____ db
Coupling.....-C _____ db
Total..... P_m _____ dbm
Rated.....-(_____)dbm
Difference..... _____ db

Overall Performance

Differences _____ db..... _____ db
Overall Difference.....(b-f) _____ db
Transmitter Frequency Skipping....No ☐ Yes ☐
Double Moding.....No ☐ Yes ☐

TR Recovery

Range..... _____ miles

Transmitter Pulling; AFC Tracking

Transmitter Pulling: No ☐ Yes ☐
AFC Tracking.....Good ☐ Poor ☐

Beacon Response of Radar

Receiver Tuning

BEACON

Preliminary
_____ ma
_____ ma
_____ ma

Trans. P_{av}
_____ dbm
A _____ db
C _____ db
P_{av} _____ dbm
_____ dbm
_____ db

f_t on Beacon
f_t _____ mc

f_r for Beacon
_____
f_r _____ mc

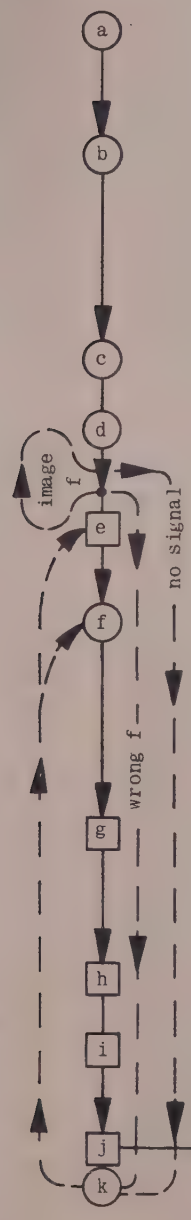
P_m for Beacon
_____ dbm
-A _____ db
-C _____ db
P_m _____ dbm
-(_____) dbm
_____ db

Maintenance Notes:

DETACH HERE

RADAR PERFORMANCE DATA SHEET

Radar _____ Serial No. _____ F-M Test Set No. _____ Observer _____ Date _____



SEARCH

Preliminary Procedure

Radar Modulator Current..... _____ ma
Radar Rectifier Current..... _____ ma
Radar Crystal Current..... _____ ma

Transmitter Average Power

DBM Dial Reading..... _____ dbm
Cable Attenuation.....A _____ db
Coupling.....C _____ db
Total..... P_{av} _____ dbm
Rated..... _____ dbm
Difference..... _____ db

Transmitter Frequency

Reading _____ , Frequency..... f_t _____ mc

Receiver Frequency

Reading..... _____
Frequency..... f_r _____ mc

Receiver Bandwidth

Readings (1) _____ (2) _____
Bandwidth, f_1 _____ f_2 _____ B _____ mc

Receiver Performance Figure (Sensitivity)

DBM Dial Reading..... _____ dbm
Cable Attenuation.....-A _____ db
Coupling.....-C _____ db
Total..... P_m _____ dbm
Rated.....-(_____)dbm
Difference..... _____ db

Overall Performance

Differences _____ db..... _____ db
Overall Difference.....(b-f) _____ db
Transmitter Frequency Skipping....No ☐ Yes ☐
Double Moding.....No ☐ Yes ☐

TR Recovery

Range..... _____ miles

Transmitter Pulling; AFC Tracking

Transmitter Pulling: No ☐ Yes ☐
AFC Tracking.....Good ☐ Poor ☐

Beacon Response of Radar

Receiver Tuning

BEACON

Preliminary

_____ ma
_____ ma
_____ ma

Trans. P_{av}

_____ dbm
A _____ db
C _____ db
P_{av} _____ dbm
_____ dbm
_____ db

f_t on Beacon

f_t _____ mc

f_r for Beacon

_____
f_r _____ mc

P_m for Beacon

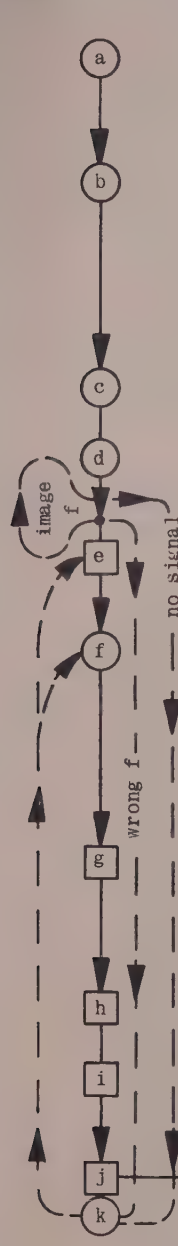
_____ dbm
-A _____ db
-C _____ db
P_m _____ dbm
-(_____) dbm
_____ db

Maintenance Notes:

DETACH HERE

RADAR PERFORMANCE DATA SHEET

Radar _____ Serial No. _____ F-M Test Set No. _____ Observer _____ Date _____



SEARCH

Preliminary Procedure

Radar Modulator Current..... _____ ma
Radar Rectifier Current..... _____ ma
Radar Crystal Current..... _____ ma

Transmitter Average Power

DBM Dial Reading..... _____ dbm
Cable Attenuation.....A _____ db
Coupling.....C _____ db
Total..... P_{av} _____ dbm
Rated..... _____ dbm
Difference..... _____ db

Transmitter Frequency

Reading _____ , Frequency..... f_t _____ mc

Receiver Frequency

Reading..... _____
Frequency..... f_r _____ mc

Receiver Bandwidth

Readings (1) _____ (2) _____
Bandwidth, f_1 _____ f_2 _____ B _____ mc

Receiver Performance Figure (Sensitivity)

DBM Dial Reading..... _____ dbm
Cable Attenuation.....-A _____ db
Coupling.....-C _____ db
Total..... P_m _____ dbm
Rated.....-(_____)dbm
Difference..... _____ db

Overall Performance

Differences _____ db..... _____ db
Overall Difference.....(b-f) _____ db
Transmitter Frequency Skipping....No ☐ Yes ☐
Double Moding.....No ☐ Yes ☐

TR Recovery

Range..... _____ miles

Transmitter Pulling; AFC Tracking

Transmitter Pulling: No ☐ Yes ☐
AFC Tracking.....Good ☐ Poor ☐

Beacon Response of Radar

Receiver Tuning

BEACON

Preliminary
_____ ma
_____ ma
_____ ma

Trans. P_{av}
_____ dbm
A _____ db
C _____ db
P_{av} _____ dbm
_____ dbm
_____ db

f_t on Beacon
f_t _____ mc

f_r for Beacon
_____
f_r _____ mc

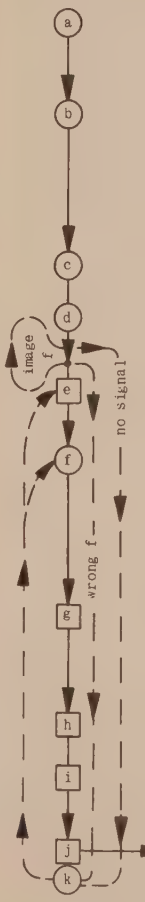
P_m for Beacon
_____ dbm
-A _____ db
-C _____ db
P_m _____ dbm
-(_____) dbm
_____ db

Maintenance Notes:

DETACH HERE

RADAR PERFORMANCE DATA SHEET

Radar _____ Serial No. _____ F-M Test Set No. _____ Observer _____ Date _____



SEARCH

Preliminary Procedure

Radar Modulator Current..... _____ ma
Radar Rectifier Current..... _____ ma
Radar Crystal Current..... _____ ma

Transmitter Average Power

DBM Dial Reading..... _____ dbm
Cable Attenuation.....A _____ db
Coupling.....C _____ db
Total..... P_{av} _____ dbm
Rated..... _____ dbm
Difference..... _____ db

Transmitter Frequency

Reading _____ , Frequency..... f_t _____ mc

Receiver Frequency

Reading.....
Frequency..... f_r _____ mc

Receiver Bandwidth

Readings (1) _____ (2) _____
Bandwidth, f_1 _____ f_2 _____ B _____ mc

Receiver Performance Figure (Sensitivity)

DBM Dial Reading..... _____ dbm
Cable Attenuation.....-A _____ db
Coupling.....-C _____ db
Total..... P_m _____ dbm
Rated.....-(_____)dbm
Difference..... _____ db

Overall Performance

Differences _____ db..... _____ db
Overall Difference.....(b-f) _____ db
Transmitter Frequency Skipping....No ☐ Yes ☐
Double Moding.....No ☐ Yes ☐

TR Recovery

Range..... _____ miles

Transmitter Pulling; AFC Tracking

Transmitter Pulling: No ☐ Yes ☐
AFC Tracking.....Good ☐ Poor ☐

Beacon Response of Radar

Receiver Tuning

BEACON

Preliminary

_____ ma
_____ ma
_____ ma

Trans. P_{av}

_____ dbm
A _____ db
C _____ db
P_{av} _____ dbm
_____ dbm
_____ db

f_t on Beacon

f_t _____ mc

f_r for Beacon

_____
f_r _____ mc

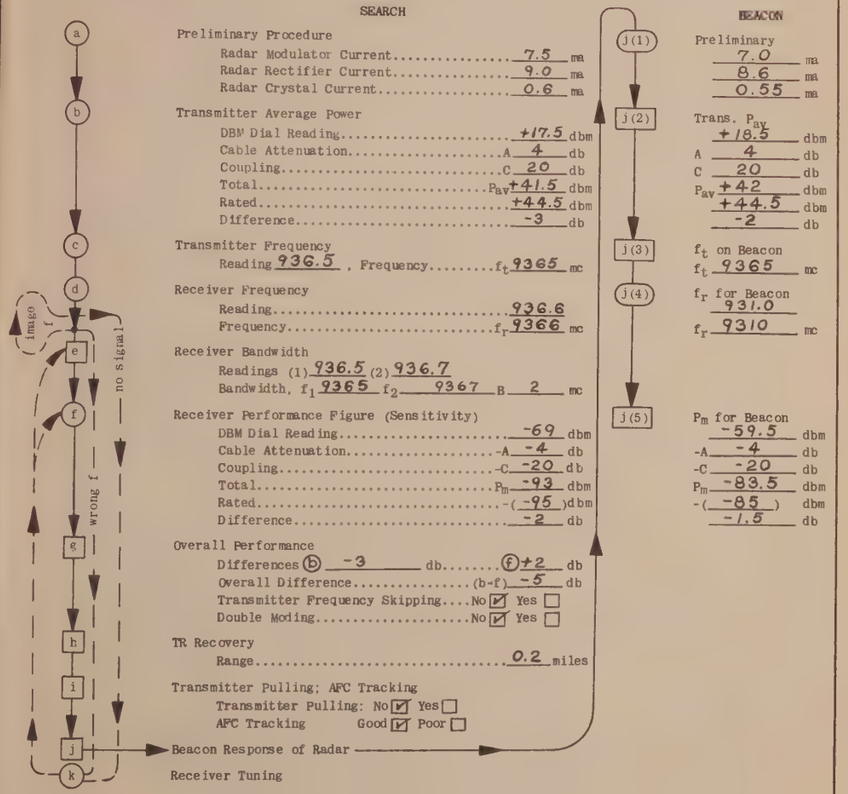
P_m for Beacon

_____ dbm
-A _____ db
-C _____ db
P_m _____ dbm
-(_____) dbm
_____ db

Maintenance Notes:

RADAR PERFORMANCE DATA SHEET

Radar AN/APS-15A Serial No. 1725 F-M Test Set No. 2 Observer FBW Date 5/12/51



Maintenance Notes:

Figure 2-12. Sample Radar-Performance Data Sheet

7. MEASURING RADAR PERFORMANCE (abridged).

NOTE

These abridged instructions are for use in sequence. Sub-paragraphs which may be skipped without upsetting following paragraphs are enclosed in square ☐ blocks on Blank Radar Performance Data Sheet. To perform individual tests out of sequence, refer to paragraph 6.

a. PRELIMINARY PROCEDURE.

(1) RADAR.-Turn radar on, observe modulator current, rectifier current, and crystal current. Leave radar spinner stationary.

(2) TEST SET.-Turn TEST to TRAN; DBM all the way counter-clockwise. Connect and turn 115V AC to ON. Connect output cable, CG-92A/U, from RF to radar directional coupler (or test horn).

(3) TS-34A/AP (Not used if Radar has A or J-Scope.)-Turn POWER ON; set to NORMAL; SWEEP SELECTOR to START-STOP; SWEEP SPEED to MED; INPUT IMPEDANCE to HIGH; ATTENUATION to 20 db. Switch to EXT SYNC and connect radar trigger to EXT SYNC (or use INT SYNC). Connect radar video signal to SIGNAL INPUT (TS-34A/AP). Adjust INPUT IMPEDANCE and ATTENUATION for convenient signal height. Adjust SYNC VOLTAGE for steady signals (check SYNC POLARITY).

b. TRANSMITTER AVERAGE POWER (P_{av}).

(1) BALANCE METER.-With TEST to TRAN and DBM full counter-clockwise, adjust METER BALANCE FINE control until meter reads zero.

(2) SET POWER.-Turn DBM dial clockwise, reducing attenuation until meter pointer is below 1.0 milliwatt. Detune FREQUENCY meter. Set meter to 1.0 milliwatt by turning DBM dial counter-clockwise Read DBM dial and record.

(3) COMPUTE TRANSMITTER AVERAGE POWER (P_{av}).-Compute as follows:

P_{av} = +DBM reading +A +C. (See Blank Radar Performance Data Sheet.

(4) COMPARE WITH RATED P_{av}.-Compute difference from rated P_{av}.

c. TRANSMITTER FREQUENCY (f_t).-Tune FREQUENCY knob for dip inmeter reading. Carefully set to maximum dip turning FREQUENCY knob counter-clockwise to avoid backlash. Record reading and multiply by ten.

d. RECEIVER FREQUENCY.-Leave radar AFC on (if operative) and set gain sufficient to show small amount of noise.

(1) TUNE TEST SET TO RECEIVER.

(a) PREPARE TEST SET FOR TUNING.-Set TEST to TEST (dot) position between TRAN and RCVR; DBM to +15 dbm; POWER SET near maximum (clockwise); PHASE near mid-position.

(b) OBTAIN F-M SIGNAL.-Set SIGNAL WIDTH to MIN. Adjust SIGNAL FREQ. for maximum signal; set TEST to RCVR and adjust DBM knob to prevent saturation. Proceed to step (3) unless no signal is obtained over the SIGNAL FREQ. range.

(2) TUNE RECEIVER (If no test signals are observed).-Maximize crystal current with local-oscillator manual reflector voltage control. Adjust coupling, if necessary, to obtain crystal current. Tune for maximum target signals or echo-box signal with local-oscillator mechanical tuning. Readjust reflector voltage, when necessary, to obtain maximum crystal current. Then tune Test Set to receiver as in step (1). If no target signals can be observed, tune receiver with Test Set, see paragraph 7.*k.* (or use echo box).

(3) MEASURE f_r.

(a) OBTAIN BANDPASS CURVE.-Turn SIGNAL WIDTH to obtain bandpass curve. Adjust PHASE control to hold pattern on oscilloscope screen.

(b) OBSERVE FREQUENCY.-Adjust FREQUENCY control so that pip is on top of bandpass curve. Record reading and multiply by ten. If f_r differs from f_t (or beacon) by twice the radar intermediate frequency, repeat paragraph 7.*d.*(1) and select the alternative signal (clockwise rotation of SIGNAL FREQ decreases frequency). If the frequency differs from transmitter (or beacon) frequency by other than twice intermediate frequency, AFC trouble is indicated. If AFC is inoperative, see paragraph 7.*k.* for manual tuning.

e. MEASURE BANDWIDTH (Optional).

(1) OBTAIN HALF-POWER HEIGHT.-Increase the setting of DBM attenuator by 3.0 db; detune FREQUENCY meter; and mark half-power height. Restore DBM to original setting.

(2) MEASURE FREQUENCY DIFFERENCE.-Move the FREQUENCY meter pip across the curve, observing the readings at the two points where it goes through the half-power line determined in (b).

Bandwidth, $B = f_1 - f_2$.

f. RECEIVER PERFORMANCE FIGURE P_m (SENSITIVITY).-Leave RADAR AFC on (if operative) and set gain to show noise one-half of transmitter pulse or saturated signal amplitude.

(1) SET SIGNAL POWER ON C-W.-Broaden bandpass curve to maximum by turning SIGNAL WIDTH clockwise to CW, while holding pattern on screen with PHASE control. Detune FREQUENCY meter. Adjust POWER SET knob so that meter reads 1.0 milliwatt.

(2) RETURN TO F-M SIGNAL.-Turn SIGNAL WIDTH to MIN, being careful to keep the correct signal (same mode) for use.

(3) DETERMINE MINIMUM DISCERNIBLE SIGNAL.-Turn DBM attenuator until signal just disappears in noise. Move signal back and forth with PHASE knob for identification. Record DBM dial reading. Compute receiver performance figure:

P_m = -DBM reading -A -C (See Radar Performance Data Sheet.)

(4) COMPARE WITH RATED P_m.-Compute difference from rated P_m.

g. OVERALL PERFORMANCE.-Combine the difference from parts b and f of the data sheet to obtain the difference in overall performance figure from rated performance figure.

(1) CHECK FOR FREQUENCY SKIPPING AND DOUBLE MODING.-Observe waveshape patterns from PULSE ANALYZER receptacle for evidence of frequency skipping or double moding which might contribute to impaired performance figure.

h. TR RECOVERY TIME.-Leave AFC on, if operative. Adjust gain for small amount of noise.

(1) RESTORE F-M SIGNAL (which disappeared in paragraph 7.*f.*(3).-Turn DBM knob clockwise until signal height is about half way between noise and saturation.

(2) PHASE SIGNAL TOWARD TRANSMITTER PULSE.-Turn PHASE knob counter-clockwise toward MIN until signal height starts to decrease. Measure range from beginning of transmitter pulse to signal.

i. DETECTING TRANSMITTER PULLING AND CHECKING AFC TRACKING.

(1) OBTAIN BANDPASS F-M SIGNAL.-Turn PHASE knob clockwise to put signal near center of screen. Broaden signal by turning SIGNAL WIDTH part way clockwise. Set FREQUENCY meter for pip on top of curve (f_t).

(2) CHECK FOR PULLING AND PROPER AFC TRACKING.-Start radar antenna spinner. If the f-m signal moves, there is probably pulling. If it remains in synchronism with the spinner, the AFC is tracking satisfactorily.

j. BEACON RESPONSE OF RADAR.

(1) PRELIMINARY.-Switch radar to BEACON, measure crystal current and modulator current.

(2) MEASURE TRANSMITTER POWER.-Follow paragraph 7.*b.* (Most radars have different pulse lengths and repetition rates on Beacon.)

(3) MEASURE TRANSMITTER FREQUENCY.-Follow paragraph 7.*c.*

(4) MEASURE RECEIVER FREQUENCY FOR BEACON RECEPTION.-Follow paragraph 7.*d.*, substituting the beacon frequency for transmitter frequency. First tune beacon receiver by procedure of paragraph 7.*k.*, if there is no beacon AFC or tuning cavity.

(5) MEASURE RECEIVER PERFORMANCE FIGURE FOR BEACON RECEPTION.-Follow paragraph 7.*f.*

k. RECEIVER TUNING. (For use when results are not satisfactory in paragraph 7.*d.* or there is no APC.).-Switch radar from AFC to manual tuning.

(1) TUNE RECEIVER TO TRANSMITTER (OR BEACON) FREQUENCY. (To be used, if necessary, after paragraph 7.*d.*(2).)

(a) SET TEST SET ON CW.-Turn SIGNAL WIDTH clockwise to CW. Maximize meter reading with PHASE control. Leave TEST on RCVR, set DBM to about -50 dbm.

(b) SET TEST SET TO TRANSMITTER (OR BEACON) FREQUENCY.-Adjust SIGNAL FREQ to transmitter (or beacon) frequency; resetting PHASE when meter drops 10% and checking frequency by dipping meter reading with FREQUENCY control.

(c) SET TEST SET ON F-M.-Turn SIGNAL WIDTH to MIN. Set Test to TEST (dot) position.

(d) DETUNE RECEIVER LOCAL OSCILLATOR.-Set radar on manual tuning. Set local oscillator at extreme end of tuning range, but on correct side of transmitter (or beacon) frequency. Adjust local oscillator for crystal current.

(e) TUNE RECEIVER TO TEST SET.-Slowly tune radar local-oscillator mechanical tuning toward center of its range, resetting the reflector voltage when crystal current drops, and watching for f-m signal on oscilloscope. Tune mechanical tuner of receiver for maximum f-m signal and adjust reflector voltage for maximum crystal current. Set TEST to RCVR. Then, if necessary, adjust setting of DBM attenuator to prevent saturation.

(f) OBTAIN F-M BANDPASS CURVE.-Carefully broaden the SIGNAL WIDTH while holding the signal in view with the PHASE control until the bandpass curve is obtained. Adjust local oscillator to get FREQUENCY pip on top of curve.

(2) ADJUST RADAR R-F COMPONENTS.-Tune duplexer TR and ATR for maximum Test Set signal. Adjust DBM attenuator to avoid saturated signal while tuning. Adjust crystal current for proper value. Readjust L-O, TR and ATR to compensate for interaction.

(3) COMPARE AFC AND MANUAL.-Switch to AFC. If pattern moves more than half the bandwidth, the AFC needs adjustment. If pattern disappears on AFC, either the AFC is inoperative or the manual tuning is on the wrong side of the transmitter frequency.

(4) CONTINUE WITH PERFORMANCE CHECK.-Return to paragraph 7.*d.*(2).

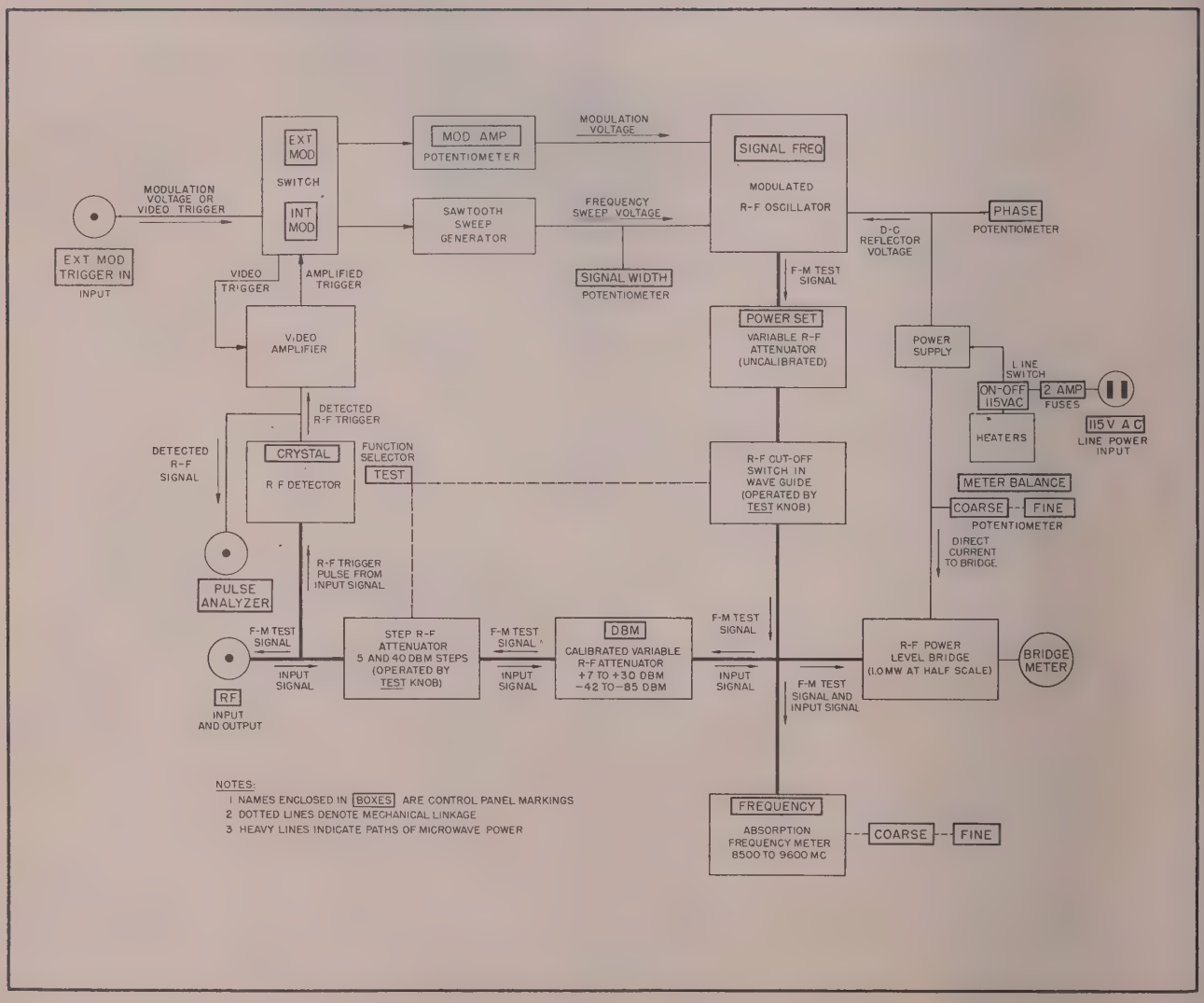


Figure 3-1. Model 38A F-M Test Set
Block Diagram

SECTION III

THEORY OF OPERATION

1. GENERAL.

a. This section describes and explains in detail the operating principles of each component in the Test Set.

2. PRINCIPLES OF OPERATION.

b. A block diagram of the Test Set components and their interconnections is shown in figure 3-1. The test signals are generated by the test oscillator which is frequency modulated by the sawtooth voltage supplied by the triggered sweep generator. The sweep generator is triggered in synchronism with the firing cycle of the radar system under test. This is accomplished either by means of voltage pulses connected to the EXT MOD-TRIGGER IN receptacle, or by microwave pulse signals applied to the RF receptacle, which are detected and amplified by the detector crystal and video amplifier.

b. The output of the test oscillator is controlled directly by means of the POWER SET attenuator and the TEST r-f cutoff control. The POWER SET attenuator provides adjustment of the signal level applied to the thermistor bridge. The TEST r-f cutoff control is a waveguide switch which prevents transmission of r-f energy from the oscillator branch to the other three plumbing branches shown in figure 3-3.

c. The output level of the test signal is measured by the DBM attenuator. When the POWER SET attenuator is adjusted for a meter reading of 1.0 milliwatt, the DBM dial indicates directly the test-signal power level at the RF receptacle. The step attenuator, operated by the TEST knob, sets the range of the DBM attenuator. When the TEST knob is in RECV position the DBM range is -42 to -85 dbm; for TEST (dot) position, the DBM range is approximately -7 to -30 dbm for readings of +7 to +30, but calibration for this range is approximate only.

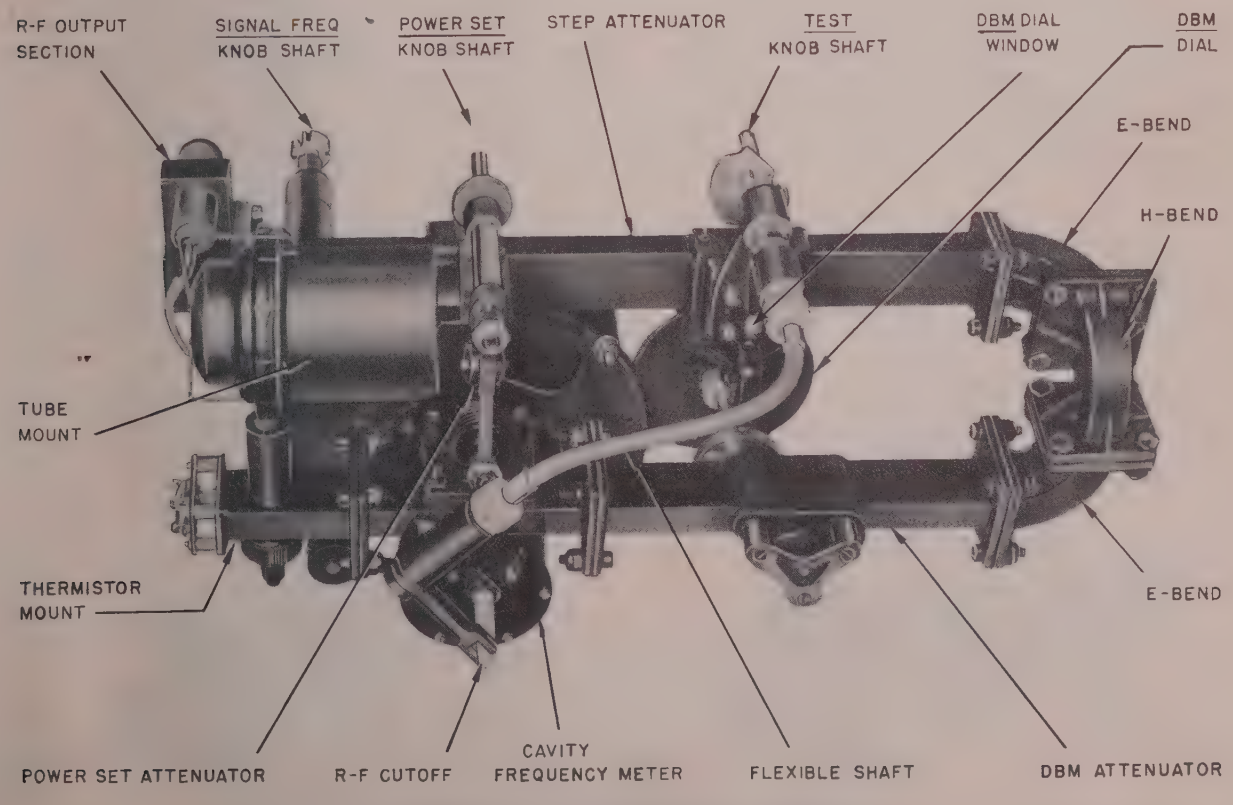


Figure 3-2. R-F Plumbing Arrangement

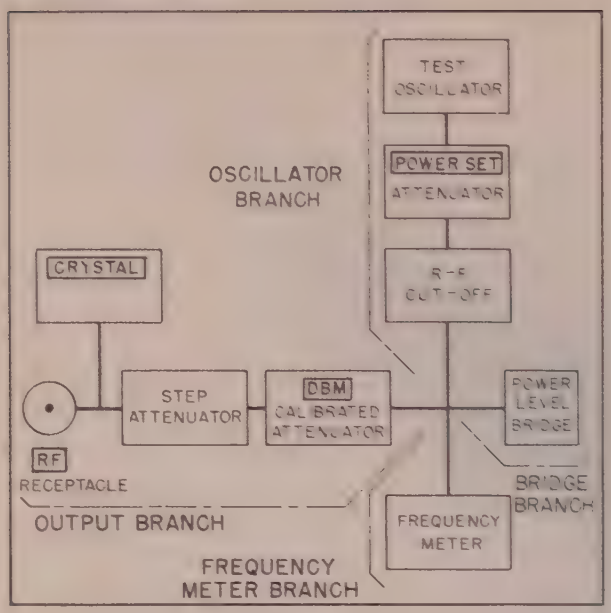


Figure 3-3. Simplified Block Diagram Showing Plumbing Branches

d. The frequency of the test signal is measured by the frequency meter. When the frequency-meter cavity is tuned to the test-signal frequency, part of the test-oscillator power traveling towards the thermistor input is reflected and a dip in the bridge meter reading is produced. The incident wave reflection caused by the resonant frequency meter also results in a decrease in the power output of the Test Set. If the test signal is frequency modulated and the frequency meter is tuned within the range of the frequency sweep, some power will be absorbed each time the frequency sweep reaches the resonant frequency of the meter. The instantaneous decrease in power output resulting from the absorption will appear as a small negative pip in the frequency response curve seen on the A-scope. See figure 2-5.

e. In addition to operating as a signal generator, the Test Set also measures the power and frequency of external r-f signals applied to the Test Set. Power is measured by means of the DBM attenuator and the thermistor bridge wattmeter. For this measurement the TEST knob is set to TRAN position to close the r-f cutoff, and the DBM attenuator range is set to +7 to +30 dbm. The DBM attenuator is then adjusted to decrease the input power to the 1.0 milliwatt level. At this point, the DBM dial indicates directly the input power level in dbm (decibels above 1.0 milliwatt).

f. Frequency of input signals is measured by the same means used for test signals. At resonance the frequency meter absorbs part of the power applied to the thermistor bridge. The resulting slight mismatch looking into the thermistor mount causes reflection of some of the incident power and a consequent dip in the bridge meter reading.

3. R-F PLUMBING COMPONENTS.

a. GENERAL.

(1) The r-f plumbing assembly of the Test Set (see figure 3-2) consists of the various waveguide components provided to perform the microwave functions required in the operation of the instrument. Each component is a fixed, replaceable assembly, unsuited to field repair or maintenance. The replacement of any of the calibrated components will require recalibration of the Test Set.

(2) The arrangement of the plumbing comprises four branches: namely, the input (or output) branch, the oscillator branch, the bridge branch and the frequency-meter branch. The four branches are joined in a waveguide series tee to which the frequency meter is coupled by means of an iris. The four branches described are designated in figure 3-3 and will be referred to by these names in locating components in the descriptions which follow.

(3) The component assemblies of the r-f plumbing are connected by means of a gasket-flange joint (figure 3-4). These joints replace the more familiar choke-flange joints (figure 3-5) formerly used in most 3.2-cm band plumbing systems. The gasket-flange joint consists of two flanges having a 0.003-inch thick silver-plated copper gasket of the same shape as the flange faces. The joint is secured by means of four screws, one through each corner of the mating flanges and gasket.

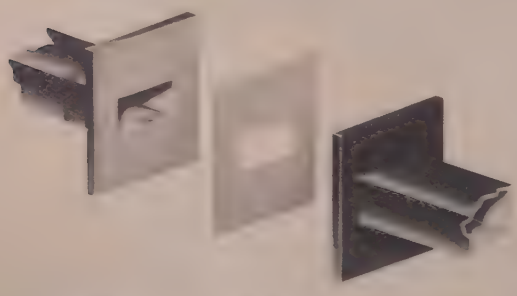


Figure 3-4. Gasket-Flange Joint

Figure 3-5. Choke-Flange Joint

b. TUBE MOUNT ASSEMBLY (figures 3-6 and 3-7).

(1) The tube mount contains the test oscillator tube (V104) and the POWER SET attenuator. The mount is a section of waveguide on which is attached an octal tube socket and shield can. When the oscillator tube is inserted in the socket, the output probe of the tube projects into the waveguide and serves as an antenna to radiate r-f power in the waveguide. The distance from the output probe to the shorted end of the waveguide is effectively one-quarter wavelength sothat energy radiated toward the shorted end is reflected back in phase with the energy radiated toward the output.

(2) The POWER SET attenuator adjusts the power transmitted to the other plumbing components from the test oscillator tube. The attenuator consists of a rectangular strip of Fiberglas coated with resistive material. Since the electric-field strength varies from maximum at the center of the waveguide to zero at the edge, the power dissipated by the fibreglas strip increases as the strip is moved towards the center of the waveguide.

(3) The metal housing and cover enclose the oscillator tube to provide an r-f shield for minimizing any r-f leakage from the tube. The housing also shields the oscillator tube from air currents which would cause variations in frequency due to temperature changes.

c. FREQUENCY METER ASSEMBLY (figures 3-8 and 3-9).

(1) The frequency meter assembly consists of the frequency meter resonator and dial together with a tee section of waveguide which contains the r-f cutoff. The tee section connects the assembly to the three other branches of the plumbing defined in figure 3-3. The r-f cutoff is a metal shutter which opens and closes the opening of the oscillator branch at the junction of the tee.

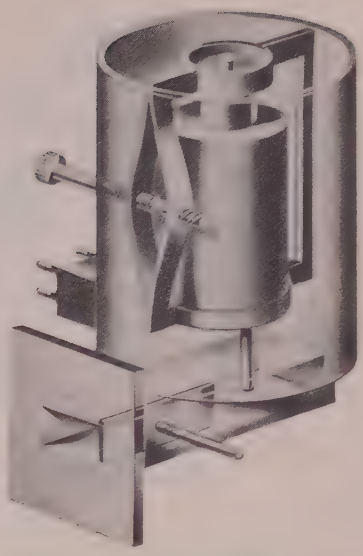
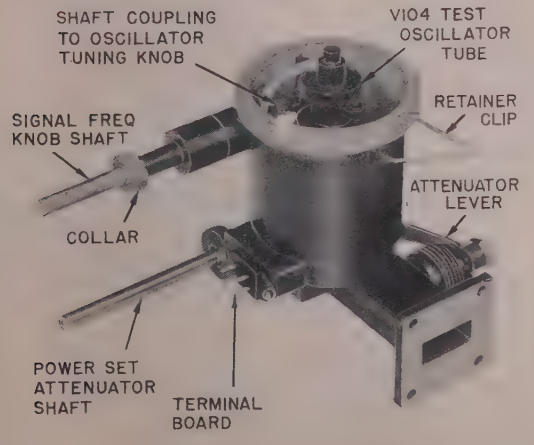


Figure 3-6. Tube Mount Assembly Simplified Phantom View

(2) The frequency meter is a cylindrical cavity resonator, the volume of which is adjustable by means of a plunger. The cavity is coupled to the tee section by means of a circular iris located in the waveguide opposite the r-f cutoff. When the length of the cavity is adjusted to one-half the wavelength of the incident microwave signal, the cavity resonates and presents a low impedance at the coupling hole. As a result, some of the transmitted power incident on the tee section is reflected before reaching the bead thermistor thus causing a decrease in the indicated power-level on the thermistor bridge meter.



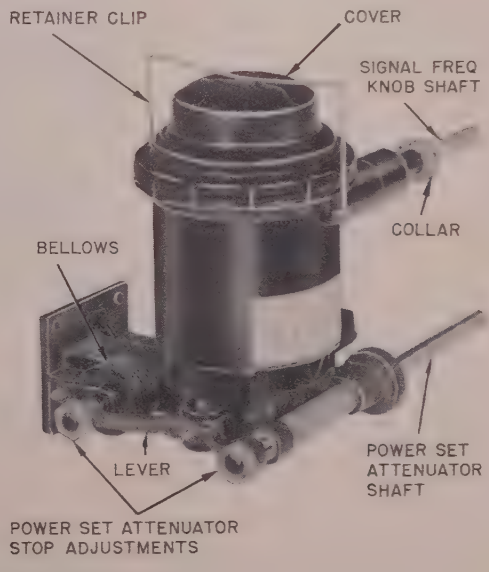


Figure 3-7. Tube Mount Assembly

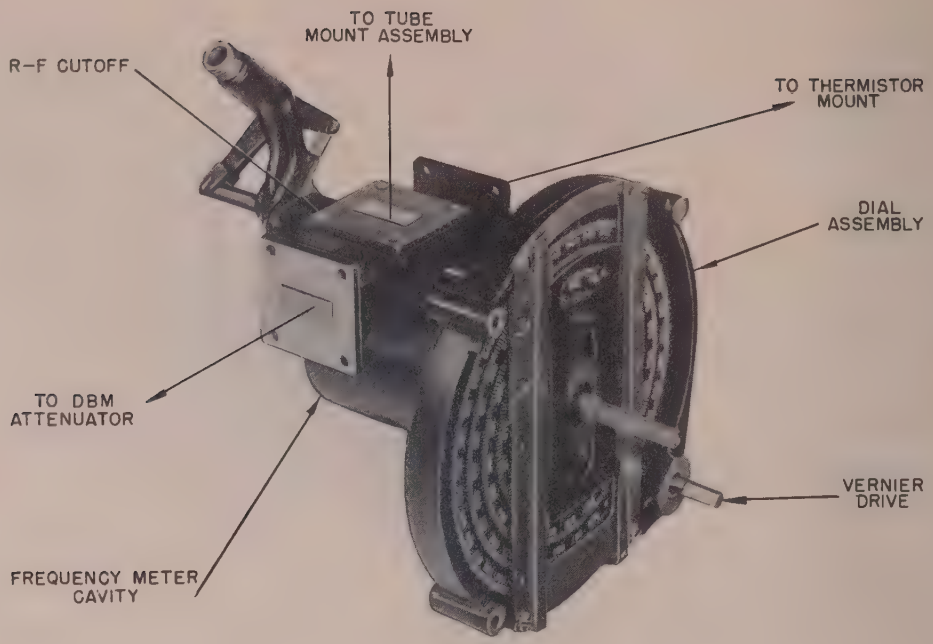


Figure 3-8. Frequency Meter Assembly

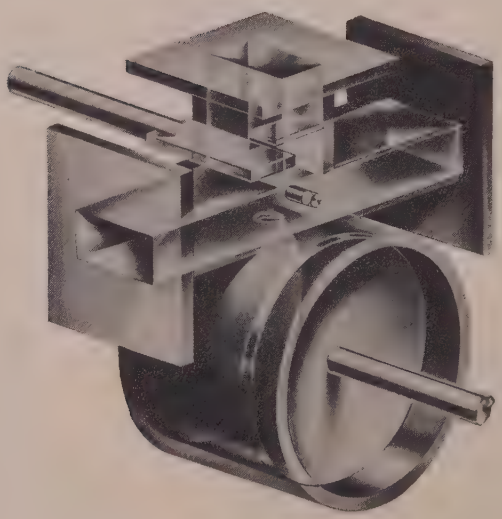


Figure 3-9. Frequency Meter Assembly
Simplified Phantom View

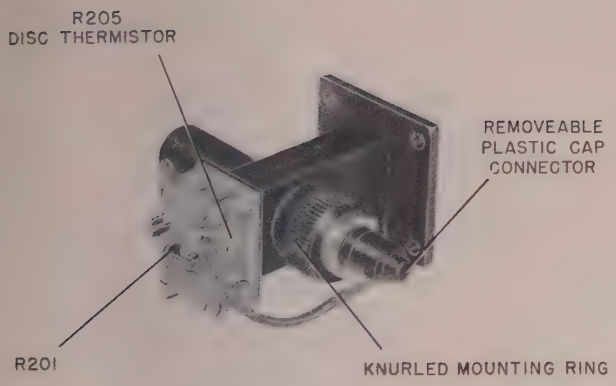


Figure 3-10. Thermistor Mount
Front View

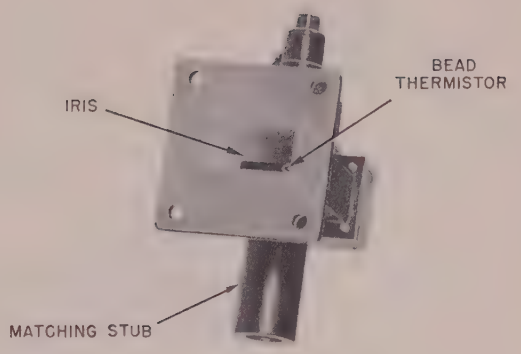


Figure 3-11. Thermistor Mount
Rear View

d. THERMISTOR MOUNT ASSEMBLY (figures 3-10 and 3-11).

(1) The thermistor mount is a section of waveguide which contains the thermistor element of the thermistor bridge circuit. The bead thermistor is mounted parallel to the voltage field (E-plane) in the waveguide. A matching stub and an iris are provided to match the impedance of the section to the connecting plumbing components.

(2) A disk thermistor is attached to the outside surface of the shorted end of the mount to provide for temperature compensation. This thermistor has a relatively large mass, and its resistance is affected principally by the ambient temperature of the thermistor mount. The operation of the thermistor bridge circuit is described in paragraph 4.*d.* of this section.

(3) Matching resistor, R201, is attached to the thermistor mount and changes the sensitivity of the bridge meter to correspond to the sensitivity of the thermistor bridge. This makes the thermistor mounts interchangeable without affecting the accuracy of power measurements.

e. DBM CALIBRATED ATTENUATOR (figures 3-12 and 3-13).-The DBM attenuator is a length of resistance-coated glass vane rigidly mounted to a pair of sliding rods within a section of waveguide. A linear cylindrical cam driven by the DBM knob provides the means for adjusting the position of the slide rods and the attenuator vane throughout the range of the electric field within the waveguide from minimum at the side to maximum at mid-guide.

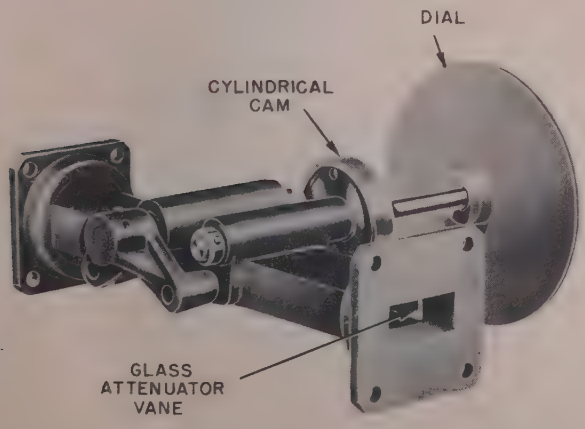


Figure 3-12. DBM Calibrated Attenuator

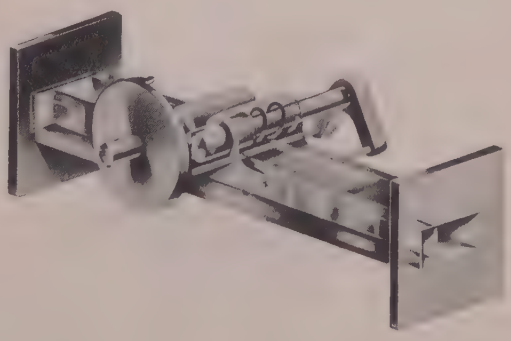


Figure 3-13. DBM Calibrated Attenuator
Simplified Phantom View

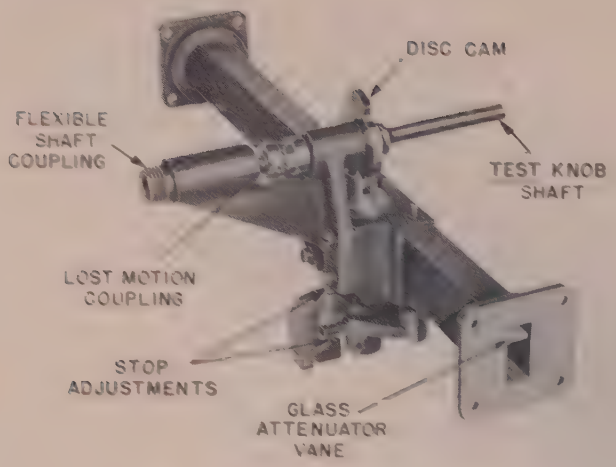


Figure 3-14. Step Attenuator

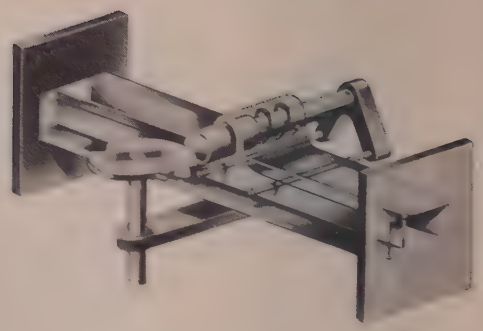


Figure 3-15. Step Attenuator Simplified Phantom View

f. STEP ATTENUATOR (figures 3-14 and 3-15).

(1) The step attenuator is a variable attenuator similar to the DBM attenuator in principle. It is used in series with the DBM attenuator to increase the attenuation range of the Test Set. The step attenuator differs from the DBM attenuator in the type of cam drive used to move the glass vane across the waveguide. Instead of a linear cylindrical cam, the step attenuator uses a disc cam with three detents. Two of the detents position the cam follower and the attenuator vane for minimum attenuation. The third detent sets the attenuation to a higher value. The resulting action produces two steps or levels of attenuation.

(2) The step-attenuator cam is operated by the TEST knob. The cam is set in the minimum-level detents when the TEST knob is set to the TRAN or TEST (dot) positions. For these two settings the range of the DBM dial is 7 to 30 dbm. In RECV position the TEST knob sets the cam in the third or high-level detent to change the DBM range to cover -42 to -85 dbm.

g. R-F OUTPUT AND DETECTOR SECTION (figures 3-16 and 3-17).

(1) The output section consists of a coupling adapter from coaxial line to rectangular waveguide and a crystal detector. The adapter couples the RF panel receptacle to the waveguide plumbing. The center conductor of the RF receptacle projects into the waveguide and becomes, in effect, an antenna which radiates into the guide. The shorted end of the guide acts as a reflector located one-quarter wave length behind the coaxial probe.

(2) The crystal-detector portion of the output section is another section of waveguide which is coupled to the main section by an iris. This secondary section is terminated by a silicon rectifier crystal capsule which detects pulse r-f power for triggering the sweep generator. Detection of pulsed r-f signals is obtainable at the PULSE ANALYZER receptacle on the control panel.

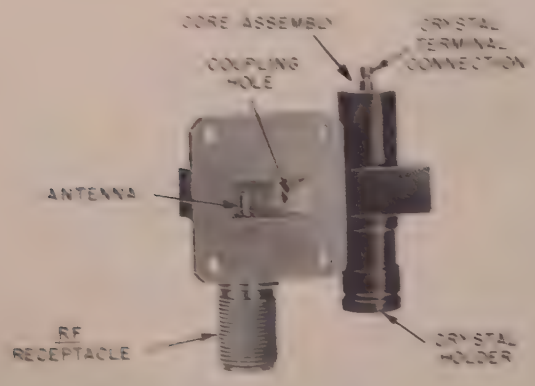


Figure 3-16. R-F Output and Detector Section

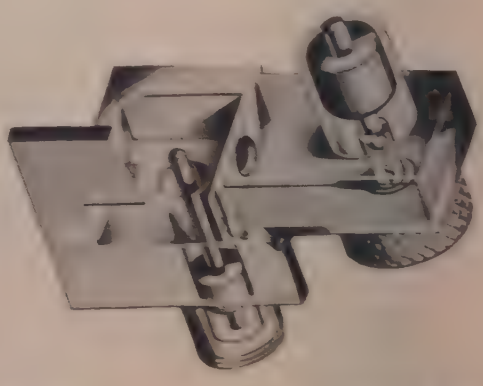


Figure 3-17. R-F Output and Detector Section Simplified Phantom View

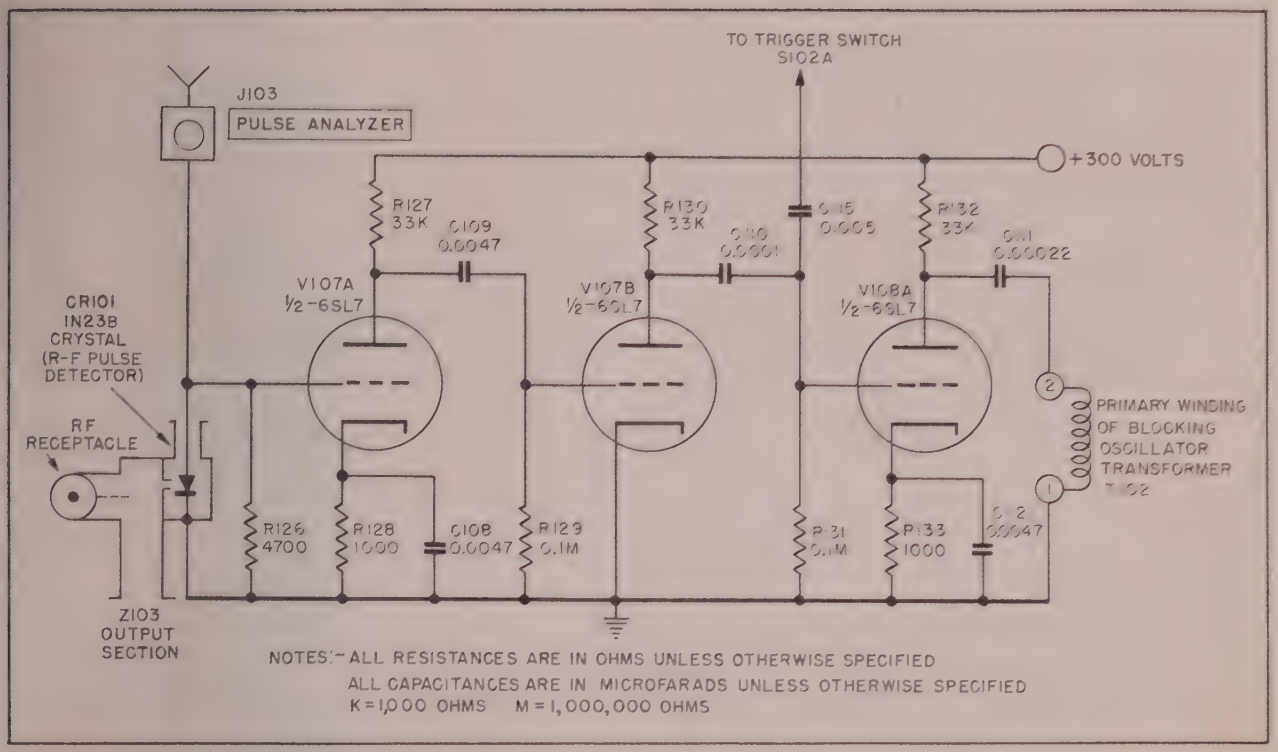


Figure 3-18. R-F Pulse Detector and Amplifier Circuit Simplified Schematic

4. ELECTRICAL CIRCUITS.

a. R-F PULSE DETECTOR AND TRIGGER AMPLIFIER CIRCUIT (figure 3-18).

(1) The r-f pulse detector and trigger amplifier circuit provides the means for triggering the frequency sweep generator from pulse r-f power applied to the RF receptacle. The r-f pulses are detected by the crystal, CR101, in the output coupling section and resulting pulse voltage is applied to the input of the trigger amplifier. The output of the amplifier supplies a voltage pulse which can trigger the blocking-oscillator sweep circuit. The output pulse is parallel fed through C111 to the primary of the blocking-oscillator transformer, T102. The amplifier is of the three-stage resistance-coupled type consisting of one and one-half 6SL7 twin triodes, V107A,B and V108A. The voltage gain is approximately 500.

(2) A video trigger is applied to the EXT MOD-TRIGGER IN panel receptacle with switch S102 on INT-FM. (See figure 3-19.) The trigger voltage pulses are fed through capacitor C115 directly to the grid of V108A, the final stage of the amplifier.

(3) External modulation (either pulse, sawtooth or square-wave) can be applied to the EXT MOD-TRIGGER IN receptacle with the switch on EXT MOD (figure 3-19). The modulation voltage is fed through capacitor C-116 directly to the reflector electrode of the test-oscillator tube.

(4) Waveshape patterns of pulsed signals applied to the RF receptacle of the Test Set can be observed on a scope. In order to view the pattern, the detected r-f pulses are fed from the PULSE ANALYZER receptacle to the oscilloscope (see figure 2-2). Observation of the waveshape will provide an indication of possible malfunctioning of the radar transmitter, resulting in frequency skipping, double modding or instability of power output (see figure 2-9). The SIGNAL WIDTH control should be set at MIN, and pulsed signals applied to the RF receptacle should not exceed one-half watt average power.

b. BLOCKING OSCILLATOR SWEEP AND TRIGGER SWITCHING CIRCUIT (figure 3-19).

(1) The frequency-sweep circuit for the test oscillator is a sawtooth generator of the triggered blocking-oscillator type. The blocking oscillator consists of one-half 6SL7 twin triode (V108B) and a three-winding transformer (T102). The circuit comprises a conventional blocking oscillator except that the grid is biased below cutoff so that a trigger pulse must be applied to start each cycle of oscil-

lation. The grid bias is applied to the cathode by the voltage divider R134 and R135.

(2) The blocking oscillator generates sawtooth pulses by discharging C114. When a trigger pulse is applied to the transformer, T102, the grid is raised above cutoff and oscillation starts. The plate current which flows during the time the grid is above cutoff causes a voltage drop across the plate resistor, R142, and part of R137. This decreases the voltage across C114 to a value below the steady-state voltage. When the single-cycle oscillation ceases, the plate current is zero but a voltage drop still exists in the load resistor, R142, due to the charging current of C114. This voltage decreases to zero as the capacitor, C114, charges to the steady-state voltage. The charging curve which occurs after the oscillation ceases is the sawtooth sweep used to modulate the test oscillator.

(3) The amplitude of the sweep voltage depends upon the steady-state voltage across the capacitor, C114. The voltage is made adjustable from 0 to +300v by means of the SIGNAL WIDTH potentiometer, R137. As the steady-state voltage is increased by the SIGNAL WIDTH control, the amplitude of the sweep voltage is increased. The limits of the control are marked CW and MIN on the control panel. CW corresponds to zero voltage, and MIN corresponds to maximum voltage. These reference marks designate the effect of the SIGNAL WIDTH control on the oscilloscope pattern obtained during receiver tests.

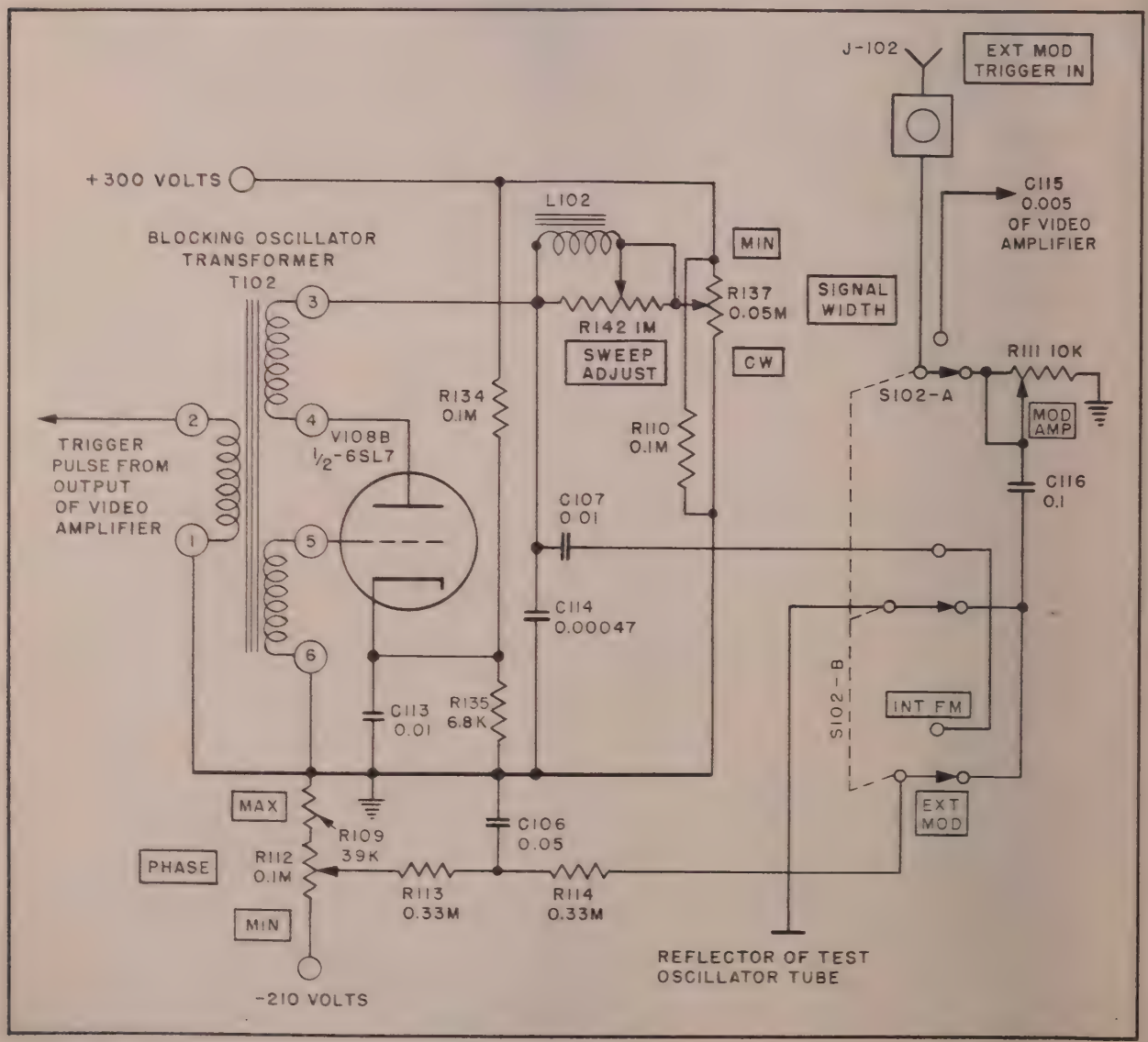


Figure 3-19. Blocking-Oscillator Sweep and Trigger-Switching Circuit - Simplified Schematic

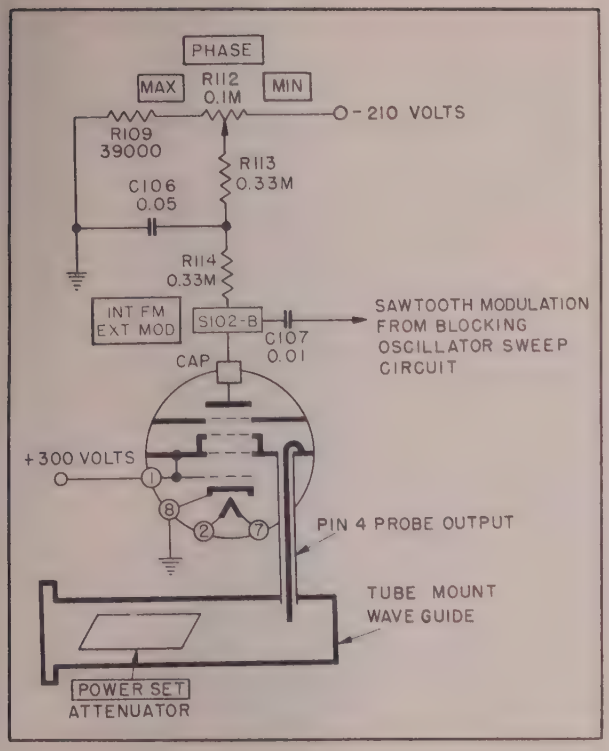


Figure 3-20. Test Oscillator Circuit Simplified Schematic

c. TEST OSCILLATOR CIRCUIT (figure 3-20).

(1) The test oscillator tube, V104, used in the Test Set is a type 723A/B or 2K25 reflex klystron. Both tubes are similar in general, except the 2K25 covers a greater band of frequencies.

(2) The reflex klystron (figure 3-21) is a velocity-modulation microwave oscillator. It consists of an electron gun which produces a focused electron beam of uniform velocity, a reentrant cavity resonator tunable through the range of operating frequencies, and a reflector electrode which decelerates and returns the electron beam towards the resonator. The electrons are emitted from the cathode and are accelerated by the positive potentials on the grid and the resonator. Assuming a varying voltage on the resonator, those electrons that arrive when it is positive will be speeded up and those that arrive when it is negative will be slowed down. This results in a "bunching" of electrons into spaced groups as they proceed down the tube. Arriving near the reflector, which is maintained at a negative potential, they are repelled. If this voltage is correctly adjusted, they will be reflected back to the resonator - when the voltage on it is such that the electron bunches are slowed down - and so deliver energy to the resonator. Energy is taken from the resonator by a coaxial probe which is terminated in the reentrant cavity by a loop. When the tube is placed in the socket of the tube mount, the coaxial probe extends into the tube-mount waveguide and acts as an antenna to radiate power.

(3) There are two methods for tuning a reflex klystron tube. The tube can be tuned mechanically by varying the volume of the resonator cavity and the spacing of the resonator grids. Decreasing the distance between the grids increases the capacitance of the resonant cavity, thereby decreasing the natural frequency of oscillation. This mechanical tuning is accomplished by rotation of the square-headed nut mounted on the tube. The tuning range is covered by approximately 3-1/2 turns of the knob, and allows a variation of approximately plus or minus six percent about a specified frequency.

(4) The second method of tuning the oscillator is by varying the reflector voltage. At only one value of reflector voltage will the transit time of the electrons be correct to enable oscillation at the natural resonant frequency of the resonator cavity. If the reflector voltage is varied slightly, the rate atwhich electron bunches will arrive at the resonator cavity will change. The tube will not stop oscillating immediately, but will shift slightly in

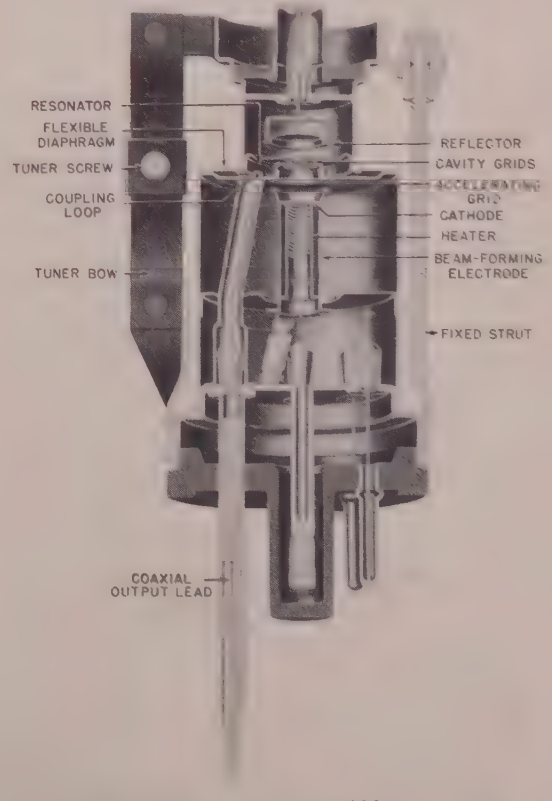


Figure 3-21. Test Oscillator Tube Cutaway View

frequency to compensate for the change in transit time. Varying the reflector voltage thus causes the frequency of the oscillator to be swept over a range of approximately 25 to 75 megacycles.

(5) As reflector voltage is varied, the tube will oscillate in different modes; the four lowest corresponding roughly to reflector voltages of minus 30, minus 75, minus 110, and minus 170 volts with respect to the cathode. The relation of power output and frequency to reflector voltage is shown for three modes in figure 3-22. These curves give approximate values for any individual tube, and indicate only average characteristics of the type 723A/B klystron. The curves indicate that the power output of the tube is greater in the modes with the more negative reflector voltages. The range of frequency sweep within each mode decreases with increasingly negative reflector voltages. Between the half-power points of the minus 75-volt mode, the frequency variation is approximately 60 megacycles. In the 110-volt mode, the frequency range is approximately 35 megacycles, and in the 170-volt mode approximately 25 megacycles. Frequency data for the 30-volt mode have not been determined accurately.

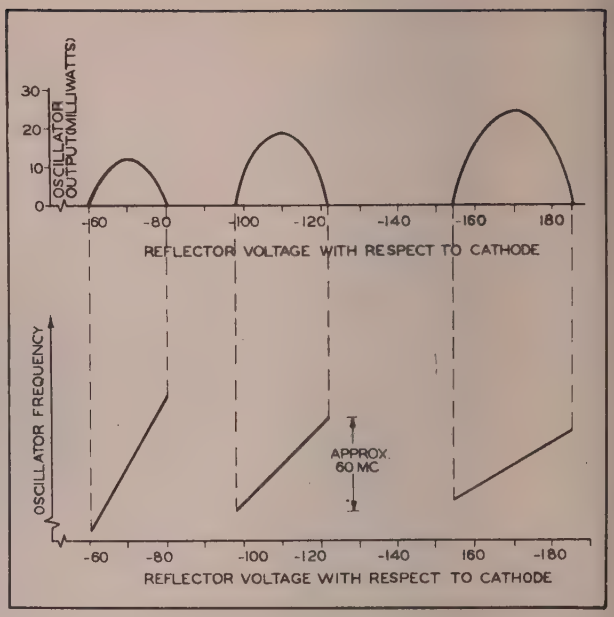


Figure 3-22. Reflex Klystron Characteristics

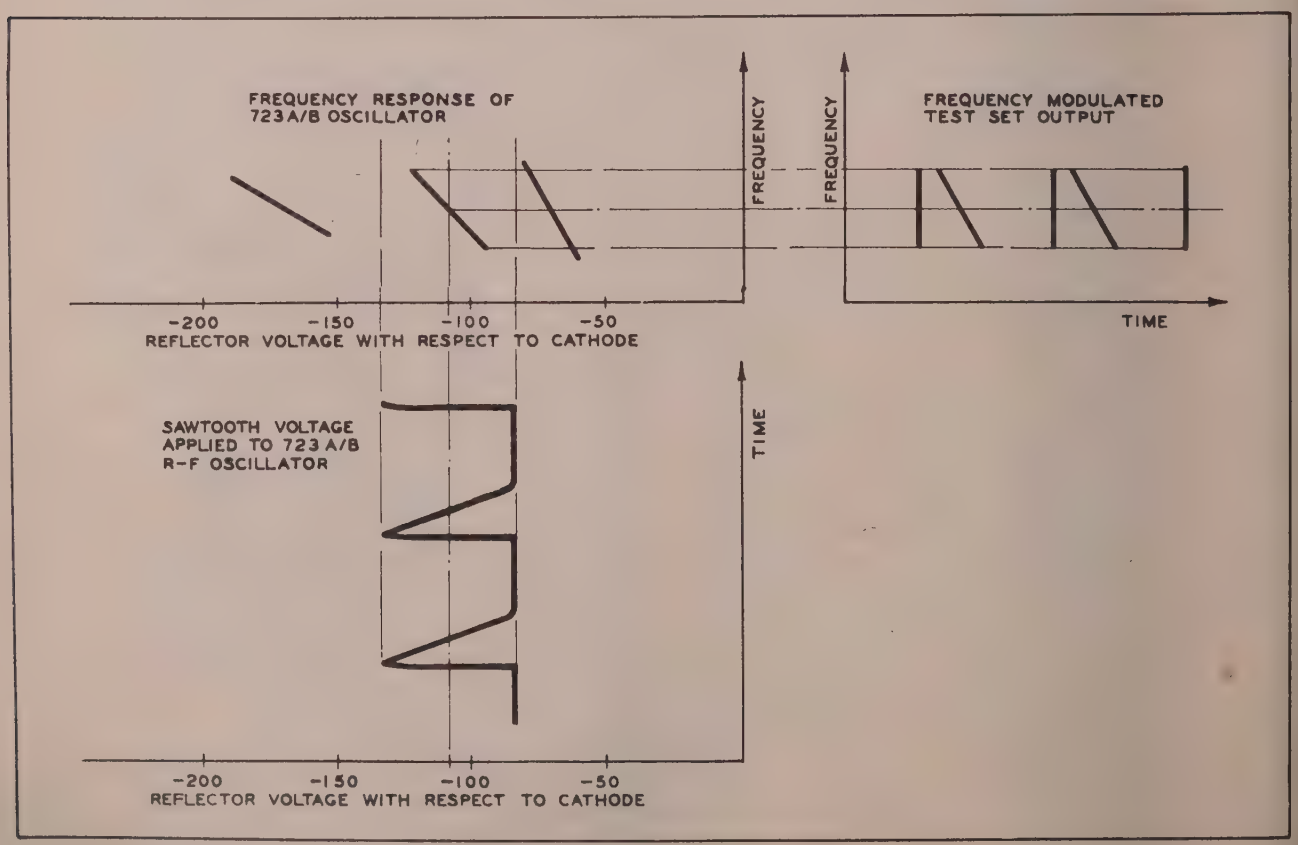


Figure 3-23. Test Oscillator Modulation

(6) Figure 3-23 shows how the frequency of the test-oscillator tube is modulated by varying the reflector voltage. If the sawtooth voltage is applied to the reflector at about the center value of 110 volts (d-c level) as shown, the frequency of the oscillator will be swept through one or more modes and the power output will be frequency modulated. The number of modes covered depends upon the amplitude of the sawtooth. This is determined by the setting of the SIGNAL WIDTH control.

(7) When it is desired to apply an external sawtooth modulating voltage to the reflector of the tube, the signal is introduced into the Test Set by way of the EXT MOD-TRIGGER IN receptacle with S102 set to EXT MOD. In this case the amplitude of the sawtooth modulation is adjusted by means of the MOD AMP control.

(8) When the d-c level of the sawtooth is changed to a lower voltage, the sawtooth will sweep over a lower mode. Also, the time at which the center frequency of the mode is reached occurs later. Such a change appears as a shift in the position of the frequency-response curve along the range axis of the A-scope. The d-c level of the sawtooth is adjusted by means of the PHASE control.

d. THERMISTOR BRIDGE CIRCUIT (figure 3-24).

(1) GENERAL.-The thermistor bridge wattmeter is a Wheatstone bridge which measures the resistance of an r-f power-sensitive resistor called a thermistor. The thermistor has a negative temperature coefficient of resistance, i.e., as the temperature is

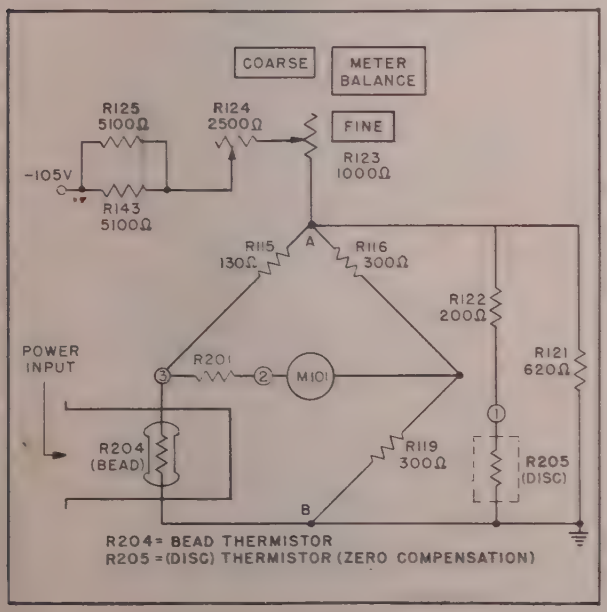


Figure 3-24. Complete Thermistor Bridge Circuit

increased the resistance decreases. The temperature, and therefore the resistance, of the thermistor is determined by the temperature of its environment, by the current flowing through it, and by absorbed r-f power. If the current and ambient temperature conditions are properly controlled, r-f power can be measured by measuring the change in thermistor resistance caused by the applied power.

(2) BASIC BRIDGE CIRCUIT (figure 3-27).

(a) There are two types of thermistors used in the Test Set. The bead thermistor (see figure 3-25),

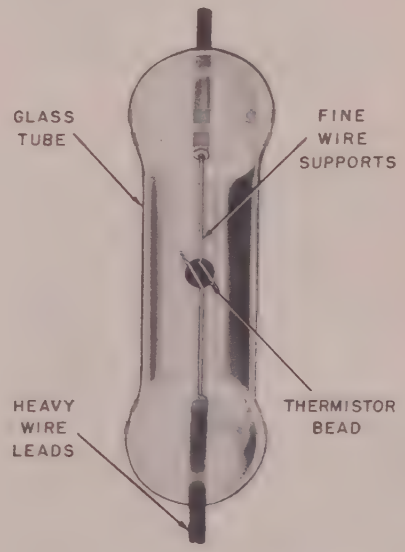


Figure 3-25. Bead Thermistor

used for r-f power measurement, has a small mass and is affected by the three changes mentioned in the preceding paragraph (4.*d.*(1)). The disc thermistor (figure 3-26), used in compensating networks, has a large mass. Its resistance is relatively insensitive to the current flowing through it and is primarily dependent upon the ambient temperature. A simplified thermistor bridge circuit is shown in figure 3-27. The Wheatstone bridge consists of three resistors, R115, R116, and R119, and the bead thermistor in the thermistor mount. When the Wheatstone bridge is balanced, no current flows in the meter. The bridge is balanced when the resistance meets the following condition:

$$\text{resistance of thermistor} = \text{R115}\,\frac{\text{R119}}{\text{R116}}$$

(b) In the bridge circuit of the Test Set "balance" is obtained by adjusting the FINE METER BALANCE control until the meter reads zero. At this adjustment the bridge is balanced and no current flows through the meter.

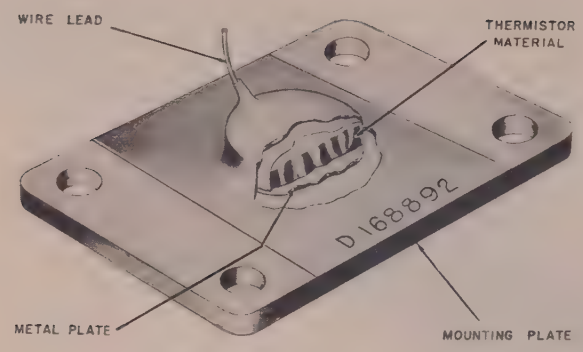


Figure 3-26. Disc Thermistor

(c) The meter is calibrated in terms of r-f power absorbed by the thermistor bead. When one milliwatt is applied to the thermistor mount, Z109, the bridge is "unbalanced" to the half-scale point on the meter. The meter current at this point is 100 microamperes and the meter reads 1 milliwatt of r-f power.

(d) This basic thermistor-bridge circuit, shown in figure 3-27, must be modified in practice to compensate for the fact that changes in the ambient temperature of the bead thermistor make it necessary to readjust the FINE METER BALANCE control before every measurement. The method employed to compensate for this effect is outlined in the following description.

(3) ZERO DRIFT COMPENSATION (figure 3-28).

(a) To eliminate the need to reset the FINE METER BALANCE control, an automatic method is provided for increasing the current through the bead thermistor with decrease in ambient temperature. A disc thermistor whose resistance increases with decreasing temperature is placed in parallel with the bridge. (See figure 3-28). Since more current flows through the bridge at lower temperatures, the ratio of the resistance of the shunting disc thermistor to the resistance of the bridge (across points A and B) is greater at a lower temperature.

(b) For adjusting this compensation to cover the required temperature range, the disc thermistor is combined in a network with resistances R121 and R122.

(4) COMPENSATED BRIDGE CIRCUIT (figure 3-24).

(a) Zero drift compensation is provided for in the thermistor bridge used in the Test Set.

(b) Resistance R124, COARSE METER BALANCE control is added in series with R123, FINE METER BALANCE control, to adjust the range of the METER BALANCE to suit the particular thermistor mount in the Test Set.

(c) The compensating networks are designed for an average bead thermistor so that the compensation is correct at 0°C, 30°C, and 60°C. At intermediate points the compensation is not exact, although it is satisfactory for practical use. These networks are not perfect for any bead thermistor due to the variation in thermistor electrical characteristics. As a result, the FINE METER BALANCE control cannot be eliminated entirely.

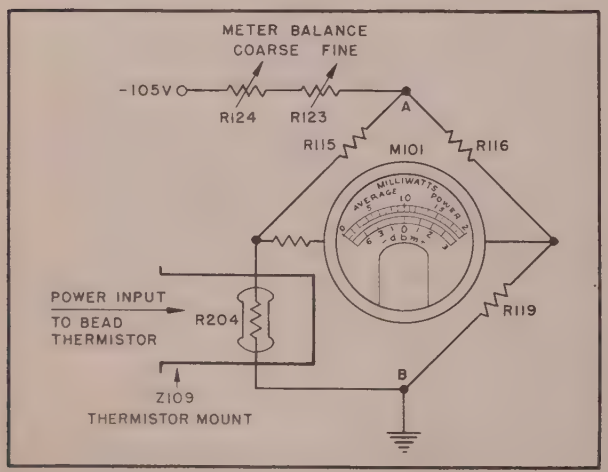


Figure 3-27. Basic Thermistor Bridge Circuit

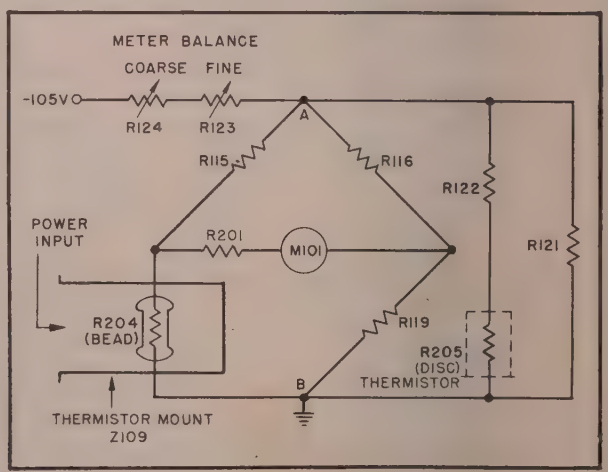


Figure 3-28. Basic Thermistor Bridge Circuit With Zero-Drift Compensation

e. POWER SUPPLY CIRCUIT (figure 3-29).

(1) The power supply provides +300 volts and -210 volts to the electrical circuits of the Test Set. The power supply consists of a full-wave rectifier V101, an electronic regulator, and a V-R tube regulator. The rectifier supplies about 550 volts d-c ungrounded, through a choke-input L-filter. The two regulators act as a voltage divider, the center tap of which is grounded. The electronic regulator on the positive side of ground regulates and filters the +300-volt supply. The V-R tube regulator on the negative side of ground regulates the -210-volt supply and provides negative bias for the amplifier tube in the electronic regulator.

(2) The electronic regulator consists of a regulator tube (V102) which controls the output voltage directly, and an amplifier tube (V103) which controls the grid voltage on the regulator tube. The amplifier tube (V103) is connected as a d-c amplifier to amplify any voltage variations in the regulator output. The amplified variations when applied to the control grid of the regulator tube (V102) cause the regulator tube to change its voltage drop in a direction which compensates for the variations.

(3) The V-R tube regulator consists of two 0B2 tubes (V105 and V106) in series. In normal operation each tube maintains a constant voltage drop of 105 volts so that the total voltage across the two in series is 210 volts. The 105-volt drop across V105 is used to supply the thermistor-bridge circuit. The total voltage (210V) of the two tubes forms the d-c reflector-voltage supply for the test oscillator tube (V104).

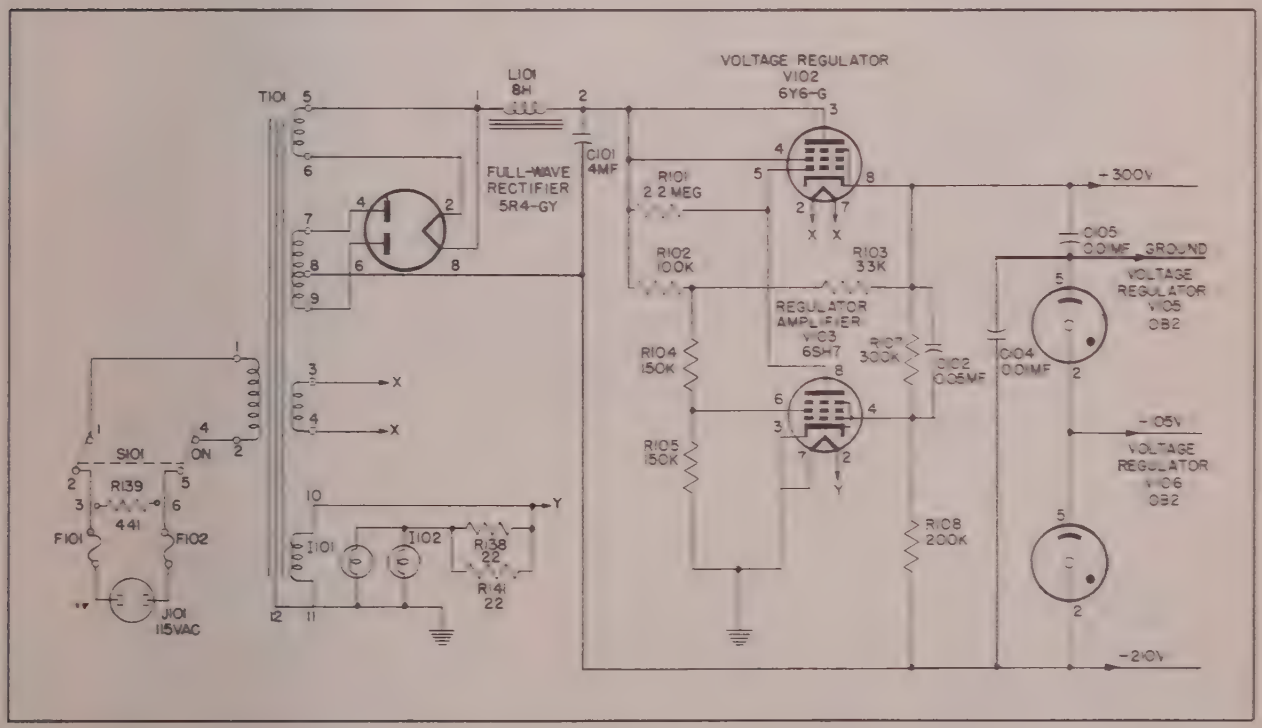
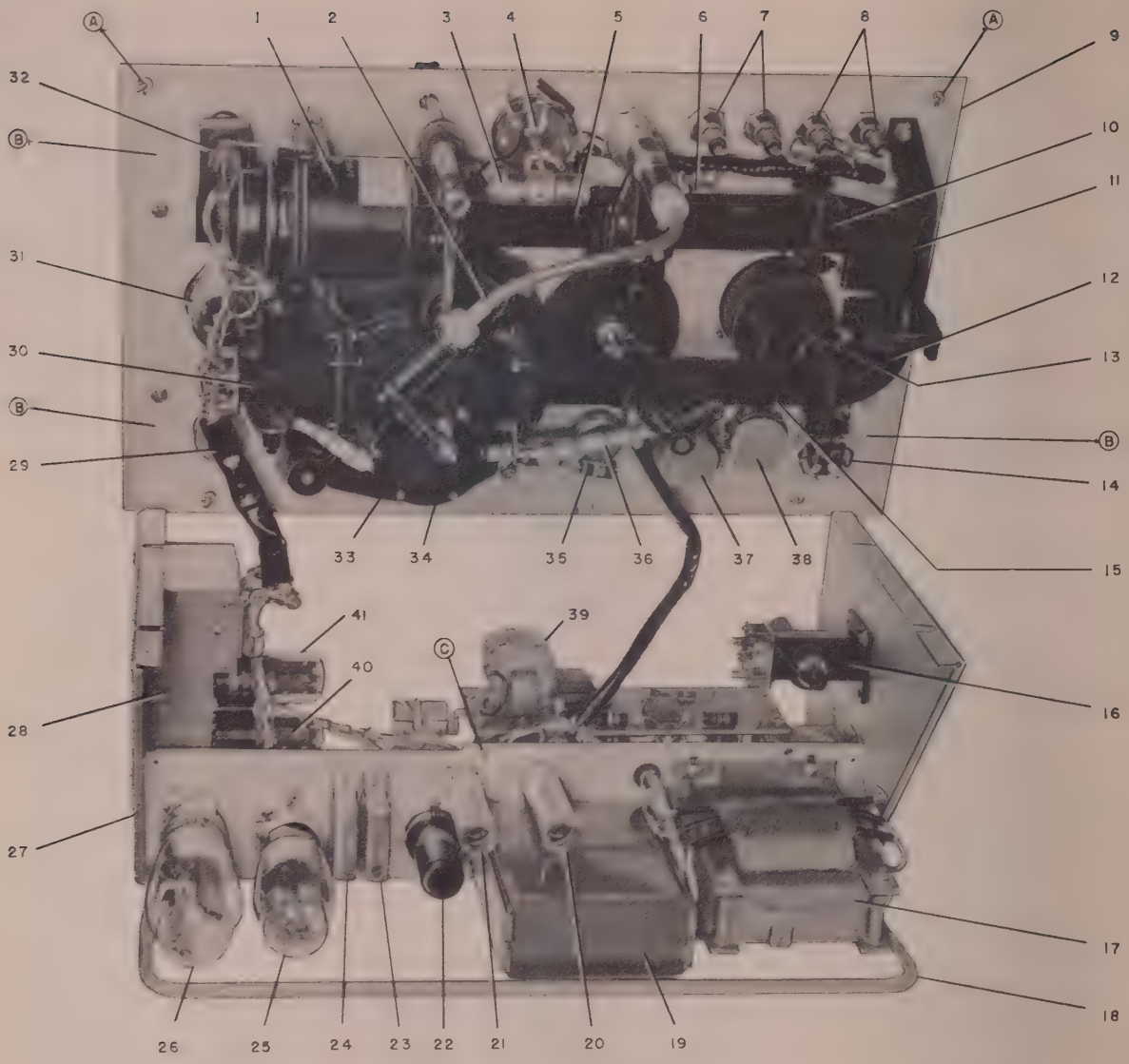


Figure 3-29. Power Supply Circuit - Simplified Schematic



1 Tube Mount Assembly Z107
2 Flexible Shaft
3 Capacitor C116
4 Switch S102
5 Step Attenuator Z101
6 Mod Amp Potentiometer R111
7 Spare Fuses
8 Fuses F101 and F102
9 Control Panel
10 E-Bend Section Z104
11 H-Bend Section Z104
12 E-Bend Section Z104
13 Bridge Meter M101
14 Switch S101
15 DBM Attenuator Z105
16 Spare Thermistor Mount Z109
17 Power Transformer T101
18 Chassis Guard Rail
19 Capacitor C101
20 V-R Tube V106
21 V-R Tube V105
22 Vacuum Tube V103
23 Capacitor C106
24 Capacitor C102
25 Regulator Control Tube V102
26 Rectifier Tube V101
27 Power Supply Chassis
28 Amplifier Unit
29 Phase Potentiometer R112
30 Thermistor Mount Z109
31 115V AC Plug J101
32 R-F Output and Detector Section Z103
33 Frequency Meter Assembly Z106
34 R-F Cutoff
35 Resistor R110
36 Signal Width Potentiometer R137
37 Meter Balance Potentiometer R123
38 Coarse-CW Potentiometer R124
39 Reactor L102
40 Blocking Oscillator Tube V107
41 Amplifier and Sawtooth Generator V107
A Cover Fasteners
B For Front Panel Retaining Screw
C For Plumbing Retaining Screw

Figure 4-1. Test Set Chassis
Top View - Control Panel Detached

SECTION IV

MAINTENANCE

1. GENERAL.

a. Because the Test Set is a calibrated measuring instrument, field maintenance is necessarily limited to trouble shooting in the electrical circuits and to replacement of complete assemblies in the plumbing. At all times field maintenance personnel must take care to avoid disturbing the fixed adjustments on any calibrated assembly. If calibration of any part is changed, then the only practical field procedure is to replace the entire assembly with a factory-calibrated unit.

b. General inspection and test of the Set can be performed by following the check described in paragraph 3 of Section II. The performance characteristics of the Test Set, stated in paragraph 7 of Section I, show quantitatively how the instrument operates when in normal condition.

2. DISASSEMBLY.

a. GENERAL.-The mechanical breakdown of the Test Set is shown by the following outline:

(1) F-M Test Set

(a) Cover
(b) Test-Set Unit

1. Cabinet
2. Chassis Assembly

a. Control Panel

(1) Plumbing Components

b. Power-Supply Chassis

(1) Amplifier Unit

b. REMOVAL OF CHASSIS ASSEMBLY FROM CABINET.

(1) Loosen the four fasteners which attach the control panel to the cabinet. These fasteners are marked A in figures 4-1 and 4-3.

(2) Carefully slide the chassis assembly out of the cabinet. Avoid bumping components against the flange in the top of the cabinet.

c. ACCESS TO AMPLIFIER UNIT.-Parts inside of the amplifier unit are accessible through an opening in the right end of the chassis. This opening is covered by a plate which is attached by two screws marked C in figures 4-2A and 4-4. In figure 4-2B the parts within the amplifier unit are identified.

d. REMOVAL OF CONTROL PANEL FROM POWER-SUPPLY CHASSIS.

(1) Lay the chassis assembly bottom down on a large flat surface.

(2) Remove the four front-panel attaching screws marked B in figure 4-3.

(3) Remove the screw which attaches the plumbing-support bracket at the center of the power-supply chassis (refer to C of figure 4-1). The bracket is located at the frequency-meter-to-DBM attenuator joint.

(4) Allow the control panel to fold out and down onto the bench. Avoid pulling or entangling the laced cable which connects panel components to the chassis. If handled properly, the cable is long enough to separate the panel and chassis sufficiently to make parts readily accessible.

e. REMOVAL OF AMPLIFIER UNIT FROM POWER-SUPPLY CHASSIS.

(1) Remove the amplifier-unit cover plate. (See paragraph 2.c.)

(2) Remove the four amplifier mounting screws marked D in figure 4-2A.

(3) The unit can now be moved away from the chassis for repair. If it is desirable to remove the unit entirely, unsolder the five wires which connect to the small square terminal board on the amplifier.

3. PART REPLACEMENT BY OPERATING SPARES SUPPLIED IN TEST SET.

a. GENERAL.-Parts of the Test Set which can be most easily damaged are supplied in duplicate within the operating-spares container located in the cover. The complete set of spares supplied with each Test Set is listed in paragraph I.4.*f*. The following replacements can be made by operating personnel.

b. GASKETS.-Nine gaskets for use in waveguide gasket-flange joints are supplied in the operating spares. These gaskets are to be used as replacements whenever gaskets are found to be corroded or damaged in disassembly of the plumbing system.

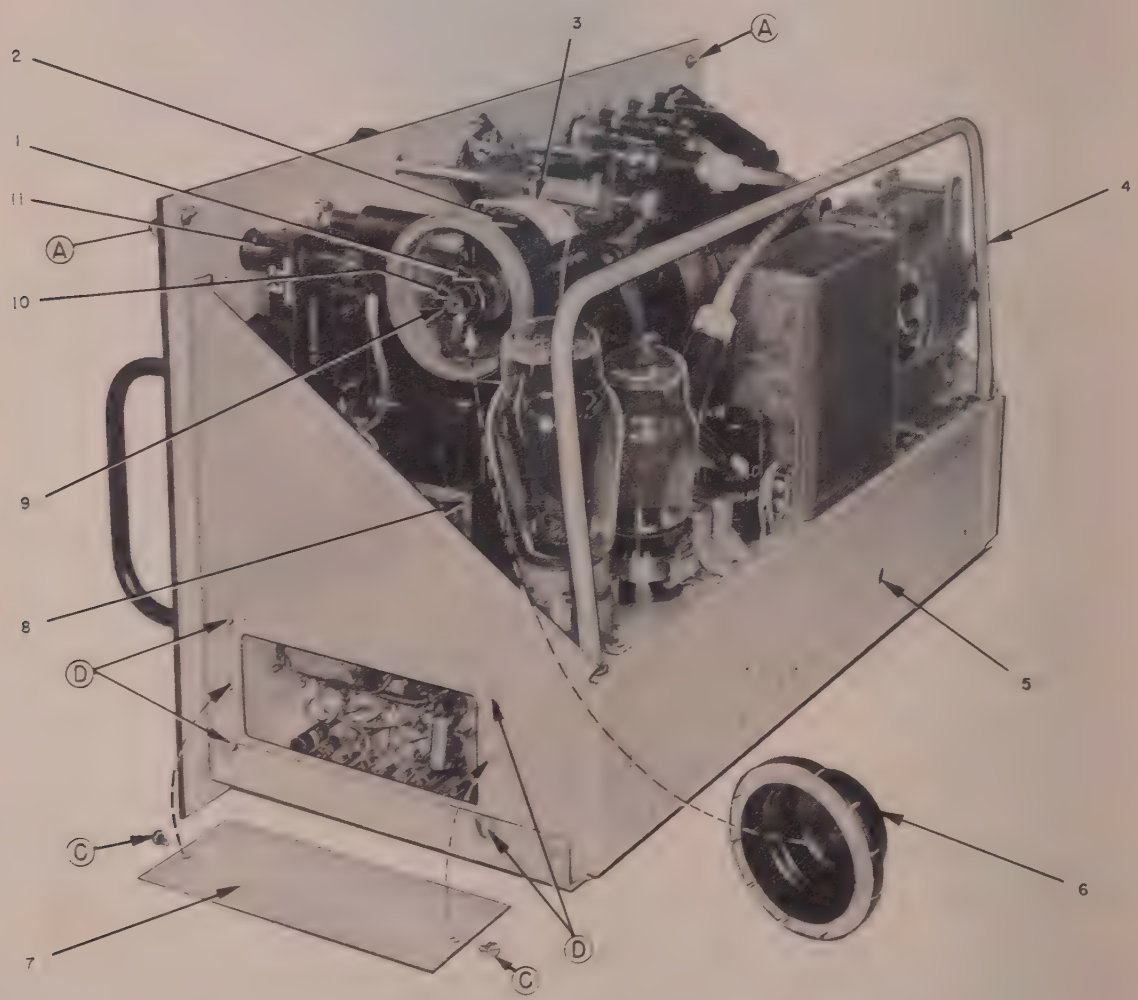
c. THERMISTOR MOUNT.-A spare thermistor mount with matched compensating resistor is furnished with each Test Set. The spare unit is attached to the left side panel near the bottom of the chassis. (See Z-109 in figures 4-1 and 4-3.) Replacement is accomplished by unsoldering the terminal-board connections on the unit in the Test Set, and removing it

from the waveguide assembly after loosening the four self-locking nuts on the flange joint. Attach the spare thermistor mount and resolder the connections to the terminal board. The thermistor bridge must be rebalanced each time this replacement is made.

d. FUSES.-Five spare fuses are supplied to replace the two fuses in the primary circuit of the power transformer. For immediate use, two of the spares are contained in the holders marked SPARES on the front panel.

e. CRYSTALS.-Two Navy-Type 1N23B silicon rectifier crystals are supplied to replace the trigger detector crystal in the RF output section. The detector crystal is replaced by removing the knurled cap marked CRYSTAL on the control panel and inserting a new crystal cartridge into the cap.

f. LAMPS.-Three 3.0-volt panel lamps are supplied to replace the lamps used to illuminate the DBM and FREQUENCY dials on the control panel. The dial lamps in use are removable from the front of the control panel. See figure 4-3.



1 Test Oscillator V104
2 Tube-Mount Assembly Z107
3 Retainer Clip
4 Chassis Guard Rail
5 Access Hole (R142) Sweep Adjustment
6 Tube-Mount Cover
7 Amplifier-Unit Cover Plate
8 Thermistor-Mount Assembly Z109
9 Connector
10 Reflector Cap
11 R-F Output and Detector Section Z103
A Cover Fasteners
C Cover Plate Mounting Screws
D Amplifier Mounting Screws

Figure 4-2A. Test Set Chassis Right-End View - Amplifier Unit Cover Plate Removed

4. TUBE REPLACEMENTS.

a. With one exception (V104), all tubes are easily accessible and can be removed and replaced in the ordinary manner. The rectifier tube, V101, and the regulator control tube, V102, are each held in place by a clamp which buckles around the base of the tube.

b. REPLACEMENT OF TEST OSCILLATOR TUBE, V104. (See figures 3-7 and 4-2A.)

(1) Release retainer clip and remove cover of tube-mount assembly.

(2) Disconnect cap of test oscillator tube.

(3) Remove collar which secures the SIGNAL FREQ. knob shaft (figure 3-7).

(4) Pull out the SIGNAL FREQ. knob shaft so that the coupling end of the shaft disengages from the tuning nut on the oscillator tube (V104).

(5) Depress one side of the flat clamp spring at the tube base and carefully pull the oscillator tube from its socket.

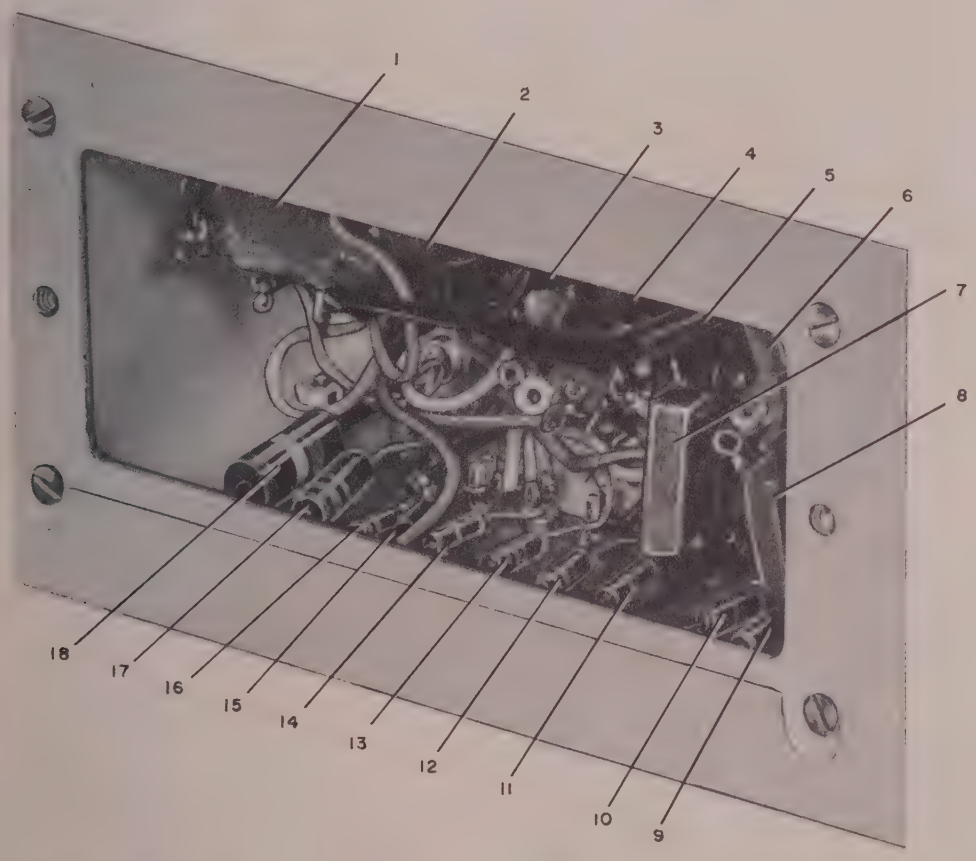
(6) Insert a new tube into the socket. The output probe of the tube fits into the enlarged pin hole (pin 4) in the socket. See that the tube is pressed all the way into the socket.

(7) Push in the SIGNAL FREQ. knob with a twisting motion until the shaft coupling engages the tuning nut on the tube.

(8) Replace the collar removed in step (3).

(9) Replace the tube cap connection.

(10) Replace the tube mount cover, and secure it in place with the retainer clip.



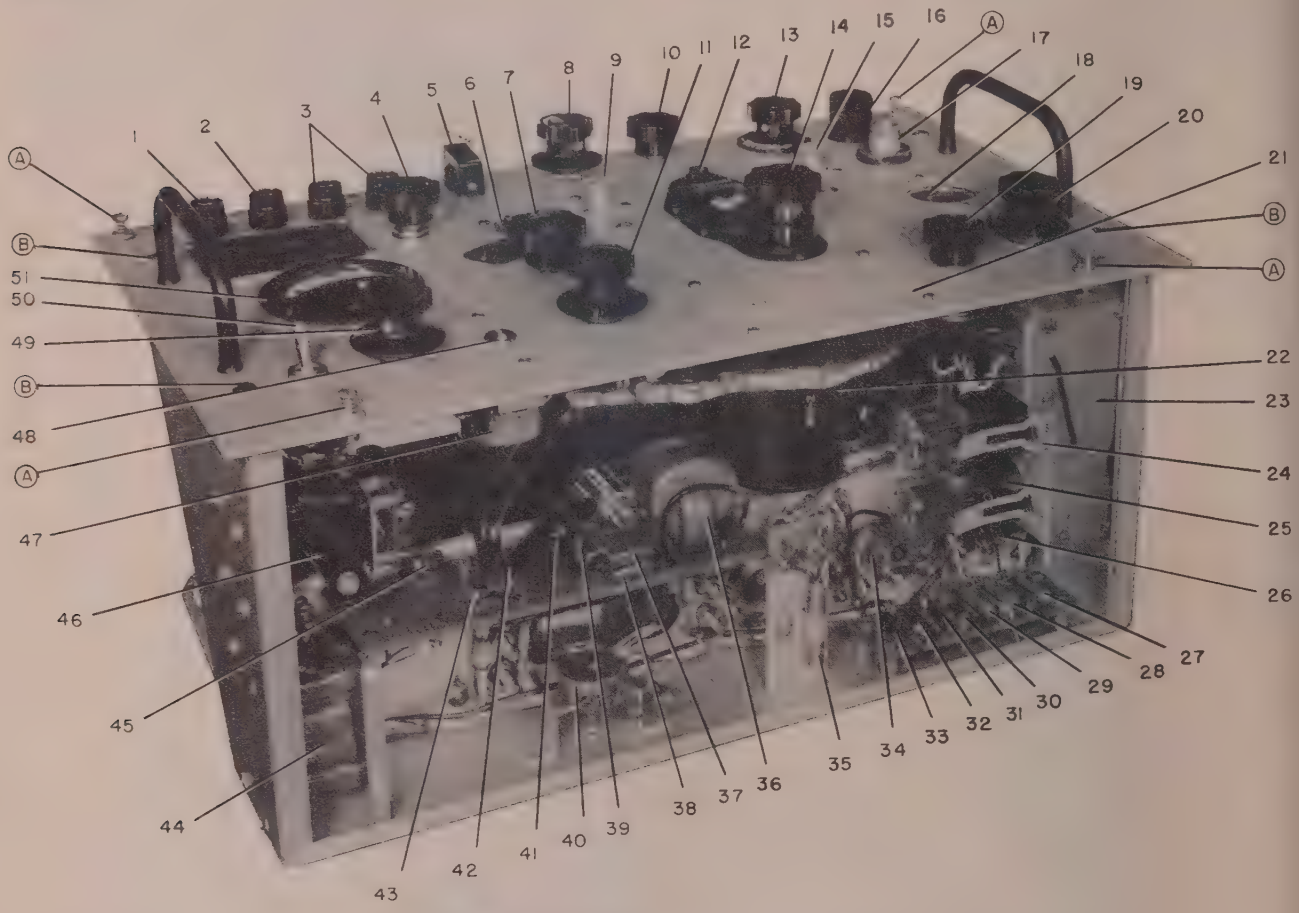
1 Transformer T102	7 Capacitor C110	13 Resistor R135
2 Capacitor C111	8 Capacitor C109	14 Resistor R131
3 Capacitor C115	9 Resistor R126	15 Resistor R133
4 Capacitor C113	10 Resistor R128	16 Resistor R132
5 Capacitor C112	11 Resistor R129	17 Resistor R130
6 Capacitor C108	12 Resistor R127	18 Resistor R134

Figure 4-2B. Amplifier Unit Close-Up View of Inner Components

5. ADJUSTMENTS.

a. GENERAL.- The Test Set contains only two adjustments which can be made by operating personnel without danger of changing the Test Set calibration. No other adjustments should be attempted in the field. For method of recalibrating the Test Set, see Section V.

b. COARSE METER-BALANCE POTENTIOMETER, R124.- The purpose of this adjustment is to set the range of the METER BALANCE control so that meter balance can always be attained. The COARSE potentiometer shaft is accessible through a front-panel adjustment port located just above COARSE. A removable cap covers the port. (See figure 4-3.)



1 Fuse F101
2 Fuse F102
3 SPARE Fuses
4 MOD AMP Control Knob
5 TEST Knob
6 Lamp I101
7 DBM Attenuator Adjustment
8 INT-FM EXT MOD Switch
9 EXT MOD-TRIGGER IN Receptacle
10 POWER SET Attenuator Control
11 SIGNAL WIDTH Control Knob
12 Lamp I102
13 SIGNAL FREQ. Control Knob
14 FREQUENCY Meter Tuning Knob
15 PULSE ANALYZER Receptacle
16 CRYSTAL Retainer Cap
17 RF Receptacle
18 115V AC Recessed Plug
19 Frequency Meter Fine Control
20 PHASE Control Knob
21 Calibration Curve
22 Frequency Meter Assembly Z106
23 Amplifier Unit
24 Amplifier and Blocking Oscillator Tube V108
25 Amplifier Tube V107
26 Tube Socket XV101
27 Resistor R115
28 Resistor R116
29 Resistor R119
30 Resistor R121
31 Resistor R122
32 Resistor R138
33 Resistor R141
34 Tube Socket XV102
35 Resistor R139
36 Reactor L102
37 Capacitor C104
38 Capacitor C105
39 Resistor R113
40 Sweep Adjust Potentiometer R142
41 Resistor R144
42 Capacitor C103
43 Resistor R104
44 Reactor L101
45 Resistor R143
46 Spare Thermistor Mount Z109
47 Coarse Meter Balance Control Potentiometer R124
48 Removable Cap for COARSE Meter Balance Control
49 FINE METER BALANCE Control Knob
50 115V ON-OFF Switch S101
51 Thermistor Bridge Current Meter M101
A Dust Cover Fasteners
B Panel Mounting Screws

Figure 4-3. Test Set Chassis - Bottom-Front View

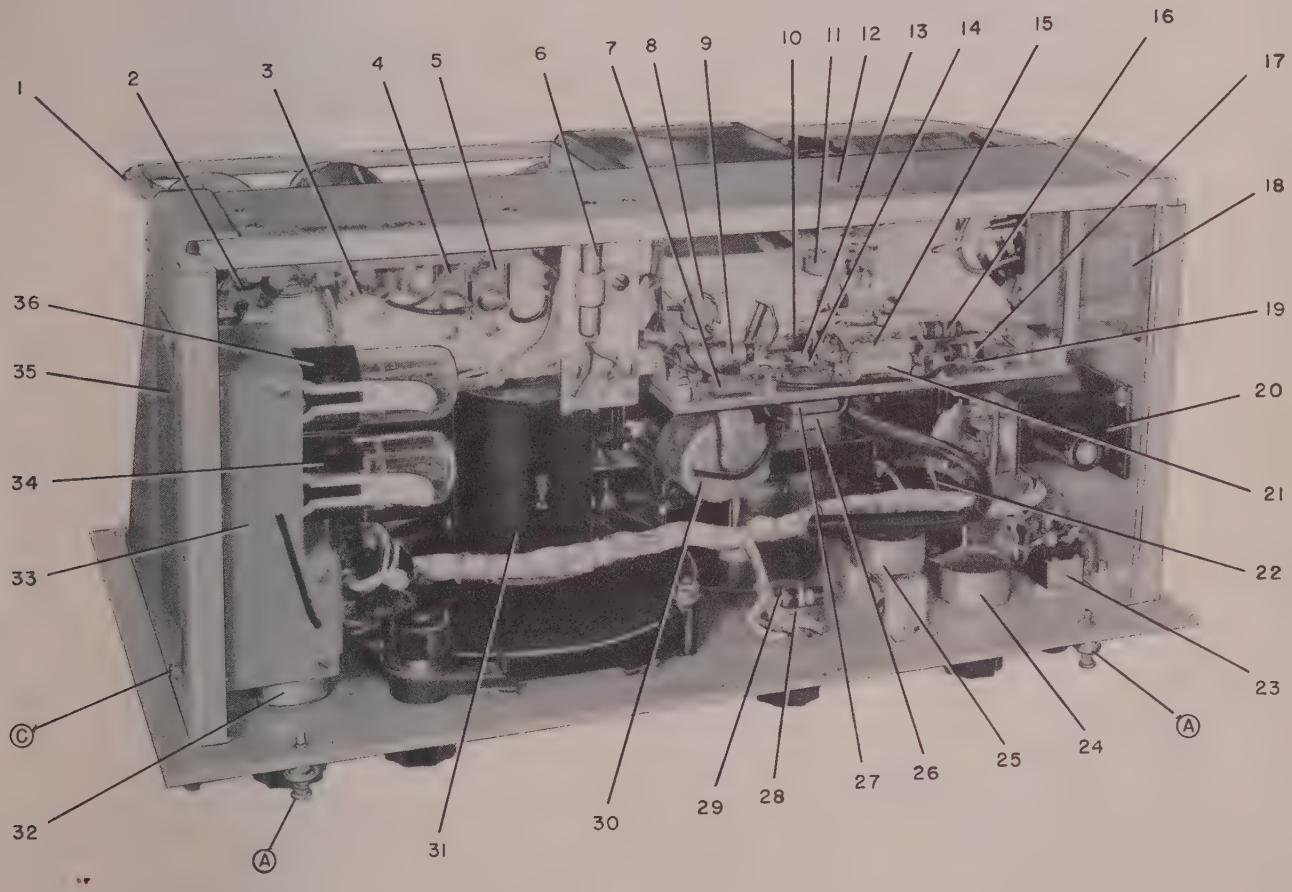
(1) Turn on the Test Set and allow about five minutes for warm up.

(2) Set the TEST knob to TRAN.

(3) Set the FINE METER BALANCE control to the middle of its range (white index mark up).

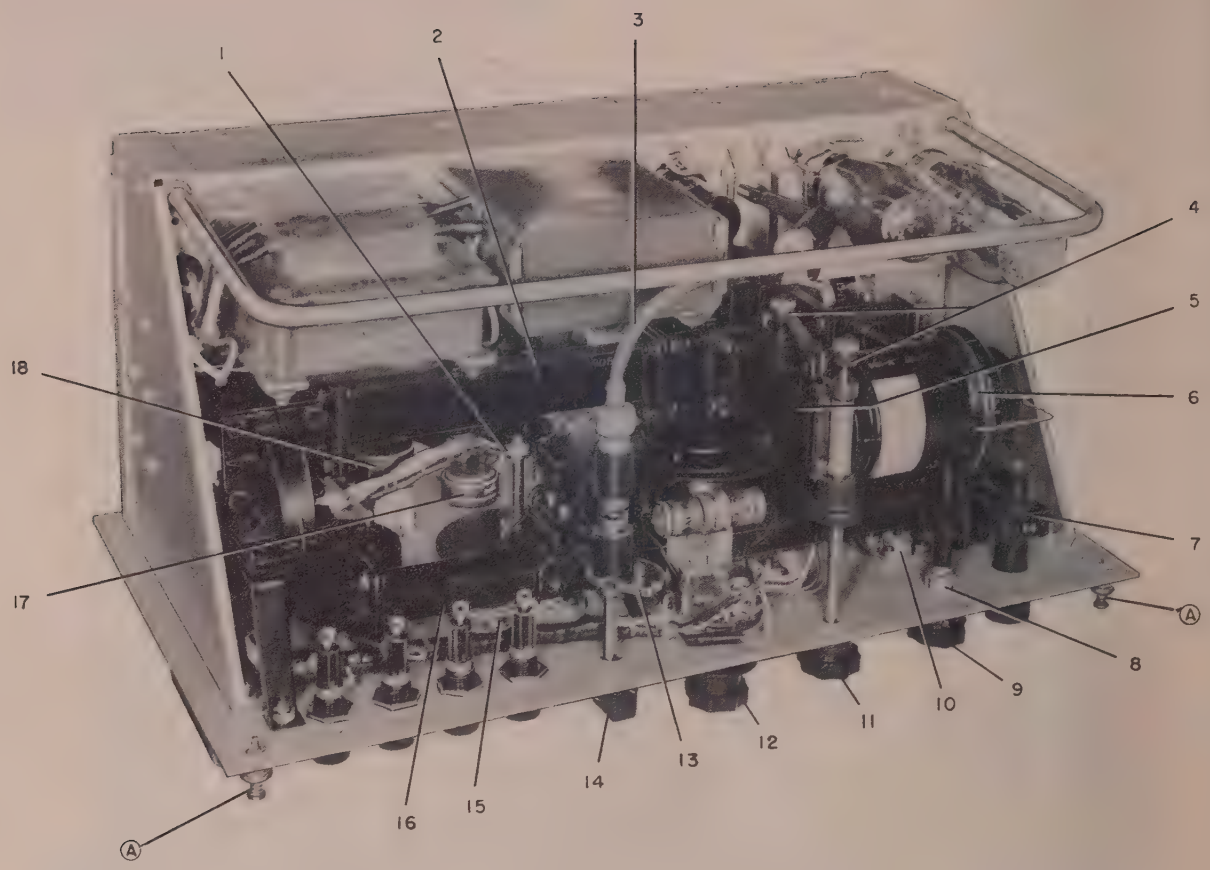
(4) Remove adjustment port cap and adjust the COARSE control potentiometer with a screwdriver until the meter is set at half scale.

(5) Replace port cap when COARSE control is set so that adjustment of FINE METER BALANCE control permits pointer to cover the entire meter scale.



1 Chassis Guard Rail
2 Socket XV101
3 Socket XV102
4 Capacitor C102
5 Capacitor C106
6 Resistor R139
7 Capacitor C114
8 Socket XV106
9 Capacitor C107
10 Capacitor C101
11 Resistor R106
12 Resistor R142
13 Resistor R114
14 Resistor R109
15 Resistor R107
16 Resistor R125
17 Resistor R102
18 Filter Choke L101
19 Resistor R105
20 Spare Thermistor Mount Z109
21 Resistor R108
22 Bridge Meter M101
23 115V AC Switch S101
24 Fine Meter Balance Potentiometer R123
25 Coarse Meter Balance Potentiometer R124
26 Capacitor C104
27 Capacitor C105
28 Resistor R137
29 Resistor R110
30 Pulse Transformer L102
31 Frequency Meter Assembly Z106
32 Phase Potentiometer R112
33 Amplifier Unit
34 Tube V108
35 Amplifier Cover Plate
36 Tube V107
A Dust Cover Fastener
C Cover-Plate Mounting Screw
F Access Hole to Sweep Adjustment R142

Figure 4-4. Test Set Chassis Bottom - Rear View



1 Dbm Attenuator Cam
2 Dbm Attenuator
3 R-F Cutoff Flexible Drive Shaft
4 Power Set Attenuator Lever
5 Power Set Attenuator
6 Tube-Mount Assembly Z107
7 R-F Output and Detector
8 Section Z103
8 Collar
9 SIGNAL FREQ. Knob
10 PULSE ANALYZER Receptacle
11 POWER SET Knob
12 INT-FM-EXT MOD Switch
A Cover Fastener
13 Step-Attenuator
14 TEST Knob
15 Mod Amp Potentiometer
16 Step Attenuator
17 Signal-Width Potentiometer
18 Coarse Meter Balance Potentiometer

Figure 4-5. Test Set Chassis Top-Rear View

c. SWEEP ADJUST POTENTIOMETER, R142.- The purpose of potentiometer R142 is to adjust the linearity, slope, and peak of the sawtooth sweep for the oscillator tube. The potentiometer shaft is accessible through the adjustment port (item 5 in figure 4-2A and item 12 in figure 4-4).

(1) Connect an oscilloscope to the reflector of V104. Trigger both the Test Set and the start-stop sweep of the oscilloscope together with a suitable trigger source.

(2) Turn on the Test Set and allow a few minutes for warm-up.

(3) Set the SIGNAL WIDTH control to MIN and the PHASE control to MAX.

(4) With a screwdriver, set the SWEEP ADJUST potentiometer so that the sawtooth voltage reaches 100 volts at 50μs. This setting should produce the most linear sweep obtainable.

6. VOLTAGE MEASUREMENTS.

The voltage measurements listed in the following table are made with the Test Set operating from a power source of 115 volts ±10%, 50 to 1600 cycles. The data compiled in the table was measured by a Weston 772 analyzer.

Component	*Terminal*[1]	*Voltage (1000Ω/volt meter)*	*Voltage (20,000Ω/volt meter)*	*Scale*
V102 (6Y6)	8	299	303	1000
V103 (6SH7)	4	-3.1	-5	10
	6	125	160	250
	8	165	248	250
V104 (2K25)	1	299	303	1000
V105 (0B2)	5 to 2	-105	-105	250
V106 (0B2)	5 to 2	-105	-105	250
V107 (6SL7)	2	214	240	250
	3	1.5	1.7	2.5
	5	175	185	250
V108 (6SL7)	2	215	235	250
	3	1.6	1.8	2.5
	5	139	200	250
	6	18	20	250
Z109 (Thermistor Mount)	3[2]	1.8	-1.8	10
Junction of R115, R116, R121, R122, R123[2]		-2.2	-2.2	10
Junction of R116, R119[2]		-1.2	-1.5	10

[1]Unless two terminals are listed, voltage is measured to ground.
[2]Meter balanced, no r-f power at thermistor.

7. CURRENT MEASUREMENTS.

a. Bridge current (through R123).....21 ma
b. Amplifier current (terminal 1).....18 ma
c. Oscillator (V104) current (terminal 4, Z107).....16 to 32 ma

8. RESISTANCE MEASUREMENTS.

The resistance measurements listed in the following table are made with the Test Set turned off and the power cable disconnected from the power source. Measurements on the thermistor mount, Z109, may vary as much as 25 percent from the values listed because of variations in bead thermistors.

Component	*Terminal*[1]	*Resistance*[2]
V102	3	135 K
	8	28 K
V103	4	150 K
	6	85 K
	8	2.2 M
V105	2	5000
V106	2	10 K
V107	1	4000
V108	5	100 K
	6	6700
L101	1	135 K
	1 to 2	310
T101	1 to 2	3.2
	7 to 8	700
	8 to 9	700
T102	3	100 K
	1 to 2	2.3
	3 to 4	2.22
	5 to 6	12.5
Z107	1	620 K
Z109[3]	1	350
	2	210
	3	210

NOTES

[1]Unless two terminals are listed, resistance is measured to ground.

[2]Values are in ohms except where K and M are used. K = 1,000 ohms. M = 1,000,000 ohms.

[3]Meter (M101) disconnected.

9. TROUBLE AND REMEDY CHART.

a. Symptom; Meter cannot be balanced by means of METER BALANCE FINE control.

Probable Cause	*Remedy*
(1) METER BALANCE COARSE control (R124) requires adjustment.	(1) Adjust R124 as described in paragraph IV.5.
(2) See symptoms b, c, d, e.	

b. Symptom; Meter off scale to right.

Probable Cause	*Remedy*
(1) Short circuit across bead thermistor in Z109.	(1) Replace thermistor mount as described in paragraph IV.3.*c*.

c. Symptom; Meter off scale to left.

Probable Cause	*Remedy*
(1) Open bead thermistor in Z109.	(1) Replace thermistor mount as described in paragraph IV.3.*c*.
(2) See symptom d.	

d. Symptoms:

(1) Meter off scale to left.
(2) V-R tubes, V105 and V106, glowing very brightly.
(3) F101 or F102 overloaded.
(4) Improper zero set on bridge meter.

Probable Cause	*Remedy*
(1) Any short circuit from +300-volt supply to ground.	(1) Remove short circuit. (a) Check polyiron terminal block in tube mount (Z107) for voltage breakdown. (b) Meter defective. Must be replaced.

e. Symptoms:

(1) Bridge circuit inoperative.
(2) Control grid of V103 glowing.
(3) V102 overheating.

Probable Cause	*Remedy*
(1) Any short circuit from -210-volt supply to ground.	(1) Remove short circuit.

f. Symptom: One dial lamp out, other lamp lit brightly.

Probable Cause	*Remedy*
(1) Either I101 or I102 is burned out.	(1) Replace burned-out dial lamp.

g. Symptom: No test-signal output indication on bridge meter.

Probable Cause	*Remedy*
(1) Defective test oscillator tube (V104).	(1) Replace V104 as described in paragraph IV.4.*b*.
(2) R-f cut-off jammed.	(2) Check cut-off mechanism and flexible shaft.
(3) Bridge circuit inoperative.	(3) See symptom e.

h. Symptom: Test-signal power output cannot be controlled by POWER SET knob.

Probable Cause	*Remedy*
(1) Broken resistive strip in power-set attenuator of tube mount (Z107).	(1) Replace tube mount (Z107).
(2) Mechanical-drive mechanism defective.	

i. Symptom: No frequency modulation of test-signal output.

Probable Cause	*Remedy*
(1) Sweep not being triggered by r-f input.	(1) Check amplifier and crystal (CR101).
(a) Transmitter output weak.	(a) Check transmitter output power.
(b) Defective crystal (CR101).	(b) Replace CR101.
(c) Weak amplifier tube.	(c) Replace V107 and V108.
(d) Defective blocking-oscillator transformer.	(d) Replace T102.
(2) Sweep not being triggered by video trigger (IFF).	(2) Check amplifier.
(a) Lack of or weak trigger voltage source.	(a) Check trigger source.
(b) Weak amplifier tube.	(b) Replace V108.
(3) Test-oscillator circuit faulty.	(3) Check SIGNAL WIDTH potentiometer (R137) and capacitors C107 and C114.

j. Symptom: Test-oscillator signals on A-scope appear jittery.

Probable Cause	*Remedy*
(1) Ripple present at reflector of test-oscillator tube (V104).	(1) Check filter of -210-volt section of power supply.
(2) Weak triggering of sweep generator.	(2) Check crystal (CR101) and amplifier.
(3) Multiple triggering of sweep generator.	(3) Check trigger source; check R134 and R135; switch radar system under test to new repetition rate.

ADDITIONAL
PICKUP HORN SPACE-LOSS RECORDS

Radar System	*D*	*H*	*Polarization*	*Space Loss*

F-M Test Set Serial No. _____ Date _____

Directional Coupler: Type _____

Serial No. _____ Pickup Horn

Data Taken By _____ Designation _____

Radar System	*D*	*H*	*Polarization*	*Space Loss*

F-M Test Set Serial No. _____ Date _____

Directional Coupler: Type _____

Serial No. _____ Pickup Horn

Data Taken By _____ Designation _____

SECTION V

SUPPLEMENTARY DATA

1. MEASURING PICKUP HORN SPACE LOSS.

a. Space loss of the pickup horn can be measured by comparison to the loss in a directional coupler. This method can be used only if a directional coupler can be installed in the type of system under test. Once the space loss for a particular type of system is determined, it is unlikely that such a measurement will have to be repeated again for each system of that type, provided that the same horn distance is always used and that the distance chosen is not critical.

b. Connect the Test Set as shown in figure 2-2 and follow steps (1) through (4) of paragraph 7.*b.* in Section II. Record the DBM dial reading.

c. Connect the Test Set as shown in figure 2-3 and follow steps (1) through (4) of paragraph 7.*b.* in Section II. Orient the horn for maximum DBM dial reading. Adjust the distance between the antenna and the horn until the least critical convenient spacing is found. Set the power and record the DBM dial reading.

NOTE

The distance between the antenna and the horn should be from about three to five feet; the best distance depending upon the radar system being tested. At some distances the coupling is critical to distance, i.e., the coupling varies greatly for small changes in distance. The best position for the horn is at the distance where this effect is minimized.

d. The space loss for the horn and the particular radar system is the difference between the DBM dial readings obtained in steps *b.* and *c.*

e. For reference, the space loss and the corresponding distance should be recorded in the following table.

Radar System	*D*	*H*	*Polarization*	*Space Loss*

D = Horizontal distance between antenna dipole and pick-up horn.
H = Vertical distance from line-of-sight of antenna.

2. MEASURING OUTPUT CABLE ATTENUATION.

a. If the output cable becomes damaged or has been repaired, the calibration of the cable has probably changed. A new attenuation calibration can be made by the following method:

b. Connect the Test Set as shown in figure 2-2. Follow steps (1) through (4) of paragraph 7.*b.* in Section II. Record the reading of the DBM dial.

c. By means of a UG-29B/U or a UG-30B/U connector, connect in series an unknown cable similar to the cable used in step *b.*

d. Repeat step *b.*

e. The attenuation of the unknown cable added in step *c.* is equal to the difference between the DBM dial readings obtained in steps *b.* and *d.*

3. ALTERNATE RECEIVER TUNING PROCEDURE.

This C-W procedure does not require an A or J-Scope, but is not as accurate as the procedure of Section II, paragraph 6.*k.*

a. PREPARE RADAR AND TEST SET.-Complete the following operations, if not already performed:

Operation	*Section*	*Paragraph*
Prepare Radar.....	II	6.*a.*(1)
Prepare the Test Set.....	II	6.*a.*(2)

b. ADJUST RADAR RECEIVER.-Set radar on manual tuning. Set gain high enough to show small amount of noise.

c. SET THE TEST SET FOR RCVR TEST.-Set TEST knob to RCVR; DBM knob to about -50 dbm; POWER SET knob near maximum (clockwise); PHASE knob near mid-position.

d. TUNING RECEIVER TO TRANSMITTER (OR BEACON) FREQUENCY.

(1) SET TEST SET ON CW.-Turn SIGNAL WIDTH knob clockwise to CW. Maximize meter reading with PHASE control. Leave TEST on RCVR. Set DBM to about -50 dbm.

(2) SET TEST SET TO TRANSMITTER (OR BEACON) FREQUENCY.-Adjust SIGNAL FREQ. knob to transmitter (or beacon) frequency, resetting PHASE knob when meter drops 10% and checking frequency by dipping meter with FREQUENCY control.

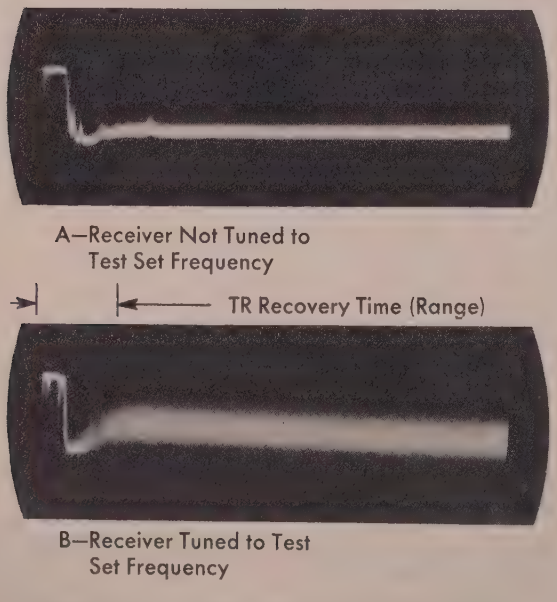


Figure 5-1. Receiver Tuning on CW and Alternate Method of Checking TR Recovery

(3) DETUNE RECEIVER LOCAL OSCILLATOR.-Set radar on manual tuning. Set local oscillator at extreme end of tuning range, but on correct side of transmitter (or beacon) frequency. Adjust local oscillator for crystal current.

(4) TUNE RECEIVER TO TEST SET.-Slowly tune receiver local-oscillator mechanical tuning toward center of its range; resetting the reflector voltage when crystal current drops and watching for CW signal on oscilloscope (appearing as intensified range sweep on PPI or B-scope, or as increased noise level on A or J-scope). See figure 5-1 for A-scope presentation. Tune mechanical tuner of receiver for maximum C-W signal, decreasing setting of DBM attenuator, if necessary, to prevent saturation.

e. ADJUST RADAR R-F COMPONENTS.- Tune TR and ATR for maximum Test Set signal. Adjust DBM attenuator to avoid flat-topped signal while tuning. Adjust crystal current for proper value. Readjust LO, TR, and ATR to compensate for interaction.

4. ALTERNATE TR RECOVERY CHECK.

The C-W procedure is useful in special cases where the T-R recovery time is short and it is not possible to phase the signal all the way into the transmitter pulse.

a. OBTAIN C-W SIGNAL.-Use any of the following alternate procedures:

(1) BROADEN F-M SIGNAL OUT TO C-W SIGNAL.-After any of the following places: Section II, paragraphs 6.*d.*(3), 6.*d.*(4), 6.*e*, 6.*f*, 6*f.*(3), 6,*h*, 6.*i*, or 6.*k*. Detune FREQUENCY meter; turn SIGNAL WIDTH knob clockwise to CW, while holding signal in sight with PHASE knob.

(2) USE C-W SIGNAL PREVIOUSLY OBTAINED.-Start after any of the following places:

Section II, paragraph 6.*f.*(6) or 6.*k.*(4).
Section V, paragraph 3.

b. SET SIGNAL HEIGHT (See figure 5-1 B).-Tune SIGNAL FREQ. knob for maximum height, keeping signal below saturation.

c. OBSERVE TR RECOVERY TIME.-Observe the range (time) at which the noise height (grass) starts to decrease (see figure 5-1 B).

5. MEASURING AVERAGE TRANSMITTER POWER BELOW +10 DBM.

When transmitter power entering the Test Set is between +1 and +10 dbm, the following procedure may be used: (The regular procedure of Section II, paragraph 6.*b.* or 7.*b.* is recommended when power entering the Test Set is between +7 dbm and +30 dbm.)

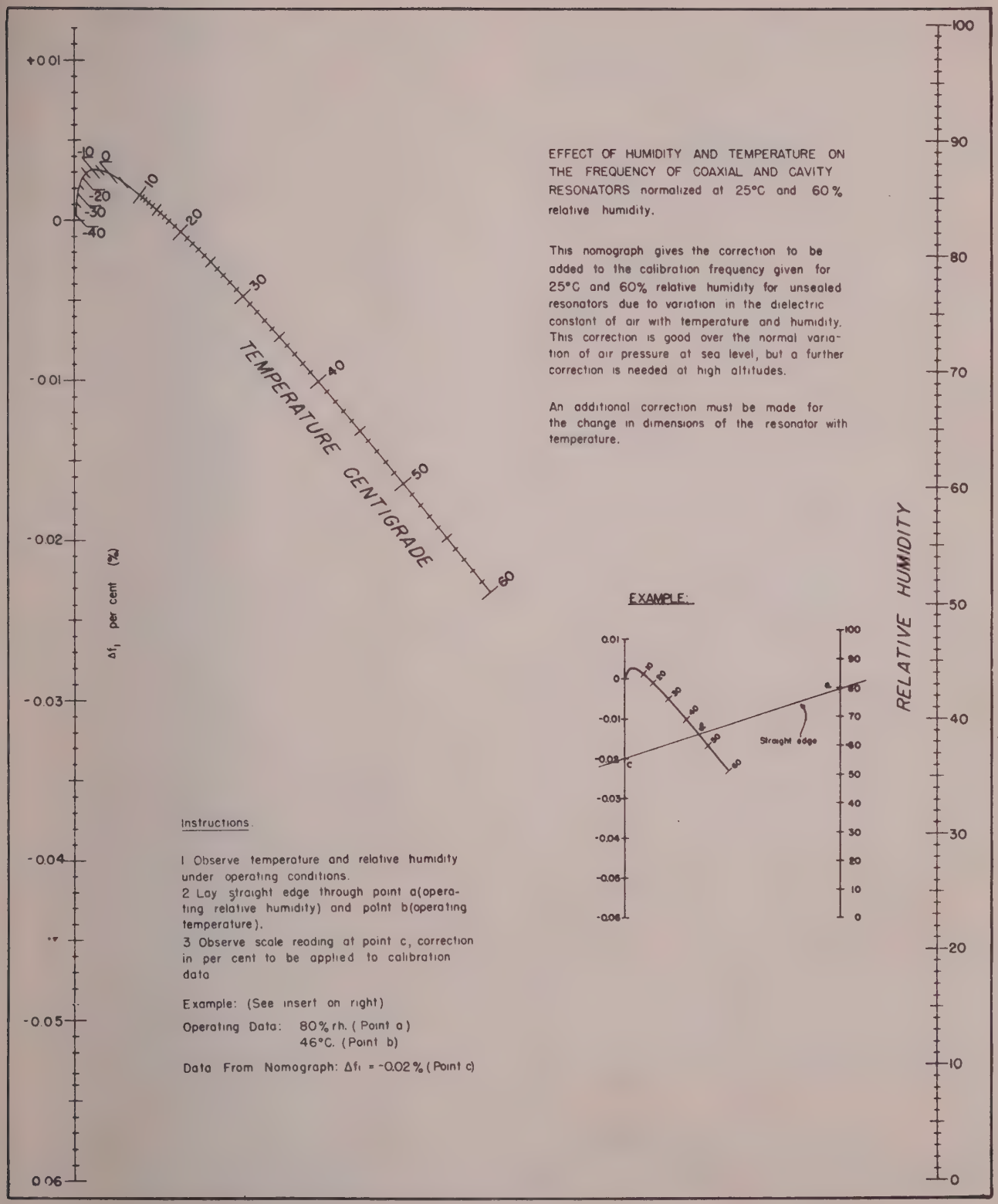

EFFECT OF HUMIDITY AND TEMPERATURE ON THE FREQUENCY OF COAXIAL AND CAVITY RESONATORS normalized at 25°C and 60% relative humidity.
This nomograph gives the correction to be added to the calibration frequency given for 25°C and 60% relative humidity for unsealed resonators due to variation in the dielectric constant of air with temperature and humidity. This correction is good over the normal variation of air pressure at sea level, but a further correction is needed at high altitudes.
An additional correction must be made for the change in dimensions of the resonator with temperature.
TEMPERATURE CENTIGRADE
RELATIVE HUMIDITY
Δf, per cent (%)
+0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-10
0
10
20
30
40
50
60
70
80
90
100
EXAMPLE:
Straight edge
a
b
c
Instructions.
1 Observe temperature and relative humidity under operating conditions.
2 Lay straight edge through point a(operating relative humidity) and point b(operating temperature).
3 Observe scale reading at point c, correction in per cent to be applied to calibration data
Example: (See insert on right)
Operating Data: 80% rh. (Point a)
46°C. (Point b)
Data From Nomograph: Δfi = -0.02 % (Point c)

Figure 5-2. Frequency Meter Corrections for Dielectric Changes Due to Temperature and Humidity

a. CONNECT TEST SET TO RADAR.-Connect Output Cable CG-92A/U from RF receptacle to radar directional coupler (or test horn) as in figure 2-2 (or 2-3). Set TEST knob to TRAN and set DBM knob all the way counter-clockwise.

b. TURN ON TEST SET.-Connect 115V AC receptacle to power line with Power Cord CX-377/U. Turn 115V AC switch to ON and wait two minutes.

c. BALANCE METER.-With TEST to TRAN and DBM full counter-clockwise, adjust METER BALANCE FINE control until meter is at zero.

d. SET DBM DIAL.-Turn DBM dial clockwise to end of travel. Then set DBM dial carefully to +10 dbm.

e. OBSERVE POWER.-Read the meter to get power in milliwatts entering the Test Set. The left-hand limit of the scale is zero milliwatts, the mid scale point is 10 milliwatts, and each major division represents an increase of one milliwatt.

f. CONVERT TO DBM.-Convert power entering the Test Set from milliwatts to dbm by use of figure 2-8.

g. COMPUTE TRANSMITTER AVERAGE POWER.-Compute as follows:

$$P_{av(dbm)} = T'_{(dbm)} + A_{(db)} + C_{(db)}$$

$P_{av(dbm)}$ = Transmitter Average Power (in decibels above one milliwatt).

$T'_{(dbm)}$ = Average r-f power entering the Test Set (in dbm). Obtained in step *f*.

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between Test Set and directional coupler (or horn) in decibels. Db loss is accurately marked on the Output Cable supplied with Test Set.

$C_{(db)}$ = Coupling of directional coupler in decibels (or space loss between radar antenna and horn).

Example: In step *e*, meter reads 4 divisions from zero point.

T' = 4 milliwatts.

From figure 2-8, T' = +6 dbm.

$P_{av(dbm)}$ = +6 +4 +20 = +30 dbm.

6. TEMPERATURE AND HUMIDITY CORRECTIONS FOR FREQUENCY METER. (Figures 5-2 and 5-3)

NOTE

The accurate results which the following corrections produce are seldom necessary in field use except for tuning the beacon local oscillator.

CAUTION

THE TEMPERATURE AND RELATIVE HUMIDITY SPECIFIED REFER TO THE CONDITIONS WITHIN THE FREQUENCY METER CAVITY. THESE CONDITIONS MAY DIFFER FROM THOSE IN THE EXTERNAL ATMOSPHERE.

a. DETERMINE CORRECTION FOR DIELECTRIC CHANGE. (Use figure 5-2.)

Example: At 46°C, 80% rh, Δf_1 = -0.02%.

b. DETERMINE CORRECTION FOR DIMENSIONAL CHANGE. (Use figure 5-3.)

Example: At 46°C, Δf_2 = -0.013%.

c. COMBINE CORRECTIONS.-Add Δf_1 and Δf_2 algebraically.

Example: $\Delta f = \Delta f_1 + \Delta f_2 = -0.033\%$.

d. CORRECT FREQUENCY OR DIAL READING.

(1) TO CORRECT OBSERVED FREQUENCY.-Convert Δf from percent to megacycles and add Δf (mc) to observed frequency.

Example: Δf = -0.033%.

FREQUENCY dial reading = 938.2

Observed frequency,

$$f_o = 9382 \text{ mc}$$

$$f = f_o + (\Delta f)\frac{f_o}{100}$$

$$f = 9382 - 0.033 \times \frac{9382}{100}$$

$$f = 9382 - 3.1 = 9378.9 \text{ mc}$$

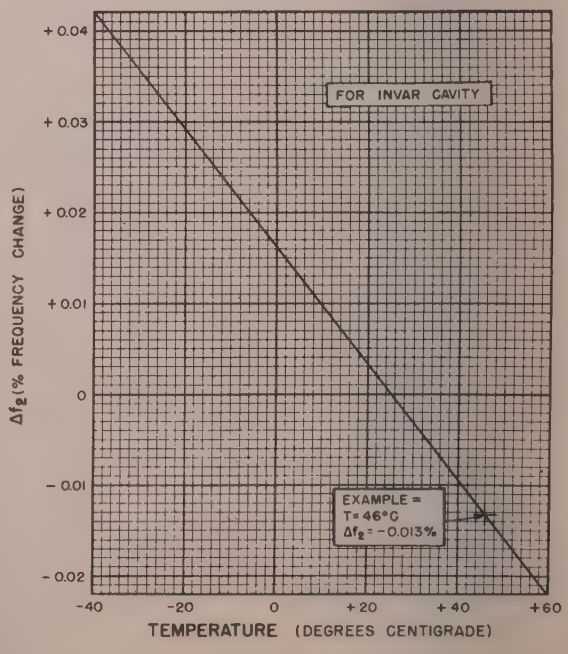


Figure 5-3. Frequency Meter Corrections for Dimensional Changes Due to Temperature

(2) TO CORRECT DESIRED FREQUENCY DIAL SETTING.-Convert Δf from percent to megacycles and subtract Δf(mc) from nominal dial reading.

Example: f = Frequency desired = 9310 mc

$\frac{f_o}{10}$ = FREQUENCY dial reading

$f_o = f - \Delta f$

$\Delta f = -3.1$ mc

$f_o = 9310 - (-3.1) = 9310 + 3.1$

$f_o = 9313.1$ mc

FREQUENCY dial reading = $\frac{f_o}{10} = \frac{9313}{10} = 931.3$

7. MEASURING C-W SIGNAL EQUAL TO NOISE.

NOTE

The c-w signal equal to noise is a measure of receiver sensitivity used in bench testing. It is related to, but not equal to, the receiver performance figure (minimum discernible signal power) used in field measurements.

a. CONNECT METER TO SECOND DETECTOR.-Connect a high-impedance vacuum-tube voltmeter between ground and the cathode of the second detector tube of the radar receiver.

b. CALIBRATE SECOND DETECTOR.

(1) OBTAIN CALIBRATED C-W SIGNAL.-Complete the following operations, if not already performed;

Operation	*Section*	*Paragraph*
Prepare Radar, Test Set and Oscilloscope.....	II	6.*f*.(1)
Adjust Radar Receiver.....	II	6.*f*.(2)
Tune Test Set to Receiver..	II	6.*f*.(3)
Check Meter Balance.....	II	6.*f*.(4)
Find Signal Again.....	II	6.*f*.(5)
Set Signal Power on cw.....	II	6.*f*.(6)

(2) ADJUST RECEIVER GAIN.-Turn receiver gain down and then increase gain until meter deflection starts to increase.

(3) CALIBRATE SECOND DETECTOR.-Turn DBM dial in one-db steps, recording DBM dial reading and corresponding voltmeter reading at second detector cathode. Plot DBM dial reading against meter deflection on graph paper to get calibration curve of meter reading vs. db. As an approximation, this calibration may be assumed a constant for units of the same type radar.

c. SET NOISE LEVEL.-With Test Set DBM dial set to maximum attenuation, turn receiver gain to a convenient level (less than half of saturation) and observe second-detector meter reading.

d. MEASURE C-W SIGNAL EQUAL TO NOISE.

(1) COMPUTE DESIRED METER READING.-From the calibration curve obtained in paragraph 7.*b*.(3) determine the meter reading corresponding to 3 db above the noise level reading obtained in paragraph 7.*c*.

(2) RESTORE C-W SIGNAL.-Adjust DBM dial to restore c-w signal obtained in paragraph 7.*b*.(1).

(3) SET C-W SIGNAL TO EQUAL NOISE.-Adjust DBM knob until meter reading computed in paragraph 7.*d*.(1) is obtained. Observe DBM dial reading.

(4) COMPUTE C-W SIGNAL EQUAL TO NOISE.

$$P_{ncw(dbm)} = (M_{(dbm)} - A_{(db)} - C_{(db)})$$

where:

$P_{ncw(dbm)}$ = Continuous-wave power input to radar which produces a power level at second detector equal to noise.

$M_{(dbm)}$ = Peak power output of the Test Set in dbm.

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between Test Set and directional coupler (or horn) in decibels.

$C_{(db)}$ = Coupling of directional coupler in decibels (or space loss between radar antenna and horn).

SECTION VI

TABLE OF REPLACEABLE PARTS

1. GENERAL

a. The following is the table of replaceable parts for the F-M Test Set manufactured by the Sperry Gyroscope Company Division of the Sperry Corporation, Great Neck, New York.

b. Each electrical part has been assigned a reference symbol, which provides the necessary cross reference between the table of replaceable parts and the schematic diagrams.

c. The reference symbol consists of a letter of the alphabet followed by a three digit number. Below is shown a list of the letters of the alphabet used throughout the table and the equivalent part's type covered by each letter.

C = Capacitors
CR = Crystal Rectifier
F = Fuse
S = Switches
T = Transformers
I = Lamp
J = Receptacle
L = Chokes
M = Meters
R = Resistors
V = Vacuum Tubes
XV = Sockets
Z = Attenuator, Wave Meter, Tube Assy etc.

d. Parts manufactured to JAN standards are indicated by their assigned JAN type designation; parts which are not JAN standard show the manufacturer's part, type or catalog number. The contractor's (Sperry) part number is provided in all cases.

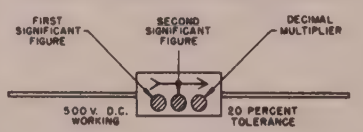
e. A list of manufacturers, which list in alphabetical order, the code symbol of the manufacturer, his name and address is provided below.

LIST OF MANUFACTURERS

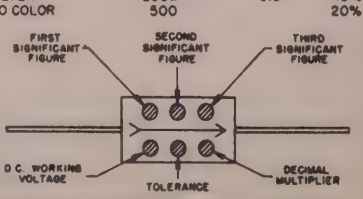
AMP	American Phenolic Corp. Chicago 50, Ill.
BSM	Bussman Mfg. Co. St. Louis 7, Mo.
BUQ	H.H. Buggie & Co. Los Angeles 41, Calif.
CNC	Cinch Mfg. Corp. Chicago 12, Ill.
HBL	Harvey Hubble, Inc. Bridgeport, Conn.
HH	Houdaille-Hershey Corp. Detroit 26, Mich.
KK	Kurz-Kasch, Inc. Dayton, Ohio
LF	Littlefuse, Inc. Chicago 40, Ill.
MZ	General Electric Co. Cleveland 12, Ohio
SPG	Sperry Gyroscope Co., Inc. Great Neck, N.Y.
WE	Westinghouse Electric Corp. Pittsburgh, Pa.
WGE	Edwin L. Wiegand Co. Pittsburgh 8, Pa.

COLOR CODES FOR CAPACITORS AND RESISTORS.

RMA COLOR CODES FOR CAPACITORS (MMFD)



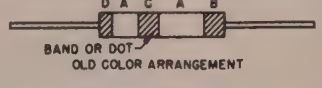
COLOR	NUMERAL	VOLTS	MULTIPLIER	TOLERANCE
BLACK	0		1	
BROWN	1	100	10	1%
RED	2	200	100	2%
ORANGE	3	300	1,000	3%
YELLOW	4	400	10,000	4%
GREEN	5	500	100,000	5%
BLUE	6	600	1,000,000	6%
VIOLET	7	700	10,000,000	7%
GRAY	8	800	100,000,000	8%
WHITE	9	900	1,000,000,000	9%
GOLD		1000	0.1	5%
SILVER		2000	0.01	10%
NO COLOR		500		20%



RMA COLOR CODE FOR RESISTORS (OHMS)

COLOR	A 1ST DIGIT	B 2ND DIGIT	C MULTIPLIER
SILVER			0.01
GOLD			0.1
BLACK		0	1.0
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
PURPLE	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	

D-TOLERANCE CODE
GOLD=5% SILVER=10% NO COLOR=20%



BODY COLOR (NEW COLOR ARRANGEMENT ONLY) INDICATES TYPE OF RESISTOR, AS FOLLOWS:,
BLACK - COMPOSITION, NON-INSULATED
TAN, OLIVE OR WHITE - COMPOSITION, INSULATED
DARK BROWN - WIRE-WOUND, INSULATED

F-M Test Set

Reference Symbol		NAME OF PART and DESCRIPTION	FUNCTION	MFR. and DESIG. or JAN TYPE	CONT. or GOVT. DWG. or SPEC. No.
C-101		CAPACITOR, fixed, mica, 4.0 mfd +20% -10%, 1500 v dc working.	Filter	CP70B1EH405V w/bkt CP07SD4	041-6
C-102		CAPACITOR, fixed, paper, 0.05 mfd ±10%, 600 v dc working.	Coupling	CP69B1EF503K	039-31
C-103		CAPACITOR, fixed, mica, 10,000 mmfd ±5%, 300 v dc working.	Noise filter	CM35D103J	015-25
C-104		CAPACITOR: Same as C-103.	Noise filter		
C-105		CAPACITOR: Same as C-103.	Bypass		
C-106		CAPACITOR: Same as C-102.	Bypass		
C-107		CAPACITOR, fixed, paper, 0.01 mfd +20% -10%, 600 v dc working.	Coupling	CP29A1EF103V	094-53
C-108		CAPACITOR, fixed, mica 4700 mmfd ±5%, 500 v dc working.	Cathode bypass	CM35D472J	015-17
C-109		CAPACITOR: Same as C-108.	Coupling		
C-110		CAPACITOR: Same as C-108.	Coupling		
C-111		CAPACITOR, fixed, mica, 220 mmfd ±5%, 500 v dc working.	Coupling	CM20D221J	011-39
C-112		CAPACITOR: Same as C-108.	Cathode bypass		
C-113		CAPACITOR: Same as C-103.	Cathode bypass		
C-114		CAPACITOR, fixed, mica 470 mmfd ±5%, 500 v dc working.	Charging, circuit, generates sawtooth wave	CM20D471J	011-47
C-115		CAPACITOR, fixed, paper, 0.1 mfd ±10%, 600 v dc working.	Coupling	CP29A1EF104K	094-56
C-116		CAPACITOR: Same as C-115.	Bypass		
CR-101		RECTIFIER, crystal.	Detector for pulsed signals	1N23B	824256-1
F-101		FUSE, glass tube type 3AG, 2 amp, 250 v dc.	Primary circuit protective device	LF 312002	042-09
F-102		FUSE: Same as F-101.	Primary circuit protective device		
I-101		LAMP, pilot, 3 v, 0.19 ± .020 amps, T-1-1/4 clear bulb.	Scale illumination	MZ 323	151514
I-102		LAMP: Same as I-101.	Scale illumination		

TABLE OF REPLACEABLE PARTS - Continued

F-M Test Set

Reference Symbol		NAME OF PART and DESCRIPTION	FUNCTION	MFR. and DESIG. or JAN TYPE	CONT. or GOVT. DWG. or SPEC. No.
J-101		PLUG, male contact, two flat parallel contacts, 1-3/8 OD x 2-1/32 lg overall.	Power input	HH 6808	235417
J-102		RECEPTACLE, one rd female contact, stght type, 1 sq x 1-1/64 lg overall.	Trigger input	BUQ 49194	240566
J-103		RECEPTACLE: Same as J-102.	Pulse analyzer		
L-101		REACTOR ASSY, filter choke, 7 henries at 10 v 120 c per sec, 45 ma dc, dc resistance 430 ohms, 2-13/16 x 1-53/64 x 1-3/4 overall.	Filter	SPG	660264
L-102		REACTOR ASSY, inductance, 6 henries ±1 henry at 10 v 1000 c per sec, 230 ohms.	Sweep reactor	SPG	662040
M-101		MICROAMMETER, dc, range 0-200 microamps ±2%, 75 ohms ±5%.	Bridge current indicator	SPG	710997
R-101		RESISTOR, fixed, composition, 2.2 megohms ±10%, 1/2 w.	Coupling (V-103) plate load	RC20BF225K	070-65
R-102		RESISTOR, fixed, composition, 0.10 megohms ±10%, 2 w.	Voltage divider	RC40BF104K	076-49
R-103		RESISTOR, fixed, composition, 33,000 ohms ±10%, 1/2 w.	Voltage divider	RC20BF333K	070-43
R-104		RESISTOR, fixed, composition, 0.15 megohms ±10%, 1/2 w.	Dc coupling	RC20BF154K	070-51
R-105		RESISTOR: Same as R-104.	Grid resistor		
R-106		RESISTOR, fixed, composition, 10,000 ohms ±10%, 2 w.	Bleeder	RC42BF103K	076-37
R-107		RESISTOR, deposited carbon, 0.30 megohm ±1%, 1 w.	Dc coupling	SPG	710340-085
R-108		RESISTOR, deposited carbon, 0.20 megohms ±1%, 1 w.	Grid leak	SPG	710340-081
R-109		RESISTOR, fixed, composition, 39,000 ohms ±10%, 1/2 w.	Limiting	RC20BF393K	070-44
R-110		RESISTOR: Same as R-102.	Bleeder		
R-111		RESISTOR, variable, composition, 10,000 ohms ±20%, 2 w.	Modulating amplitude control	SPG	0192-7
R-112		RESISTOR, variable, composition, 100,000 ohms ±20%, 1/2 w.	2K25 reflector voltage control	SPG	0191-13
R-113		RESISTOR, fixed, composition, 0.33 megohms ±10%, 1/2 w.	Filter	RC20BF334K	070-55
R-114		RESISTOR: Same as R-113.	Signal isolation		

F-M Test Set

Reference Symbol		NAME OF PART and DESCRIPTION	FUNCTION	MFR. and DESIG. or JAN TYPE	CONT. or GOVT. DWG. or SPEC. No.
R-115		RESISTOR, deposited carbon, 130 ohms ±1%, 1 w.	Part of thermistor bridge circuit	SPG	710340-005
R-116		RESISTOR, deposited carbon, 300 ohms ±1%, 1 w.	Part of thermistor bridge circuit	SPG	710340-013
R-119		RESISTOR: Same as R-116.	Part of thermistor bridge circuit		
R-121		RESISTOR, fixed, composition, 620 ohms ±5%, 1/2 w.	Zero compensation in bridge circuit	RC20BF621J	069-44
R-122		RESISTOR, fixed, composition, 200 ohms ±5%, 1/2 w.	Zero compensation in bridge circuit	RC20BF201J	069-32
R-123		RESISTOR, variable, wire wound, 1000 ohms ±10%, 2 w.	Fine meter balance control	RA20A1RD102AK	0193-18
R-124		RESISTOR, variable, wire wound, 2500 ohms ±10%, 2 w.	Coarse meter balance control	RA20A1SA252AK	0193-50
R-125		RESISTOR, fixed, composition, 5100 ohms ±5%, 2 w.	Current limiting	RC42BF512J	075-66
R-126		RESISTOR, fixed, composition, 4700 ohms ±10%, 1/2 w.	Grid leak	RC20BF472K	070-33
R-127		RESISTOR: Same as R-103.	Plate load		
R-128		RESISTOR, fixed, composition, 1000 ohms ±10%, 1/2 w.	Cathode bias	RC20BF102K	070-25
R-129		RESISTOR, fixed, composition, 0.10 megohms ±10%, 1/2 w.	Grid leak	RC20BF104K	070-49
R-130		RESISTOR, fixed, composition, 33,000 ohms ±10%, 1 w.	Plate load	RC30BF333K	073-43
R-131		RESISTOR: Same as R-129.	Grid leak		
R-132		RESISTOR: Same as R-103.	Plate load		
R-133		RESISTOR: Same as R-128.	Cathode bias		
R-134		RESISTOR: Same as R-102.	Voltage divider		
R-135		RESISTOR, fixed, composition, 6800 ohms ±10%, 1/2 w.	Cathode bias	RC20BF682K	070-35
R-137		RESISTOR, variable, composition, 100,000 ohms ±20%, 2 w.	Signal width control	SPG	0192-13
R-138		RESISTOR, fixed, composition, 22 ohms ±5%, 1 w.	Voltage dropping for lamps	RC30BF220J	072-9
R-139		HEATING ELEMENT, elec, 115 v 30 w, sgle sec.	Heater	WGE C-202	287087

Reference Symbol		NAME OF PART and DESCRIPTION	FUNCTION	MFR. and DESIG. or JAN TYPE	CONT. or GOVT. Dwg. or SPEC. No.
R 141		RESISTOR: Same as R-138.	Voltage dropping for lamps		
R 142		RESISTOR, variable, composition, 1,000,000 ohms ±20%, 1/2 w.	Sweep adjust	SPC	9191-49
R 143		RESISTOR: Same as R-125.	Current limiting		
R 144		RESISTOR: Same as R-106.	Bleeder		
R 201		RESISTOR ASSY, 250 ohms ±10%.	Matches sensitivity to thermistor	SPC	305805
R 204		THERMISTOR, bead.	Resistance varies with power dissipation	SPC	272824
R 205		THERMISTOR, disc.	Temperature compensating element	SPC	227898
S 101		SWITCH, toggle, DPDT, 30 amps, 0.010 ohms.	Power switch	ST52N	0233-4
S 102		SWITCH, rotary selector, 2 sec, 4 poles, 2 position.	Internal FM and external modulating switch	SPC	711001
T 101		TRANSFORMER, power, 115 v, 50-1600 c, sgle ph, 4 output windings, secd No 1-850 v at 36 milliamperes RMS CT, secd No 2-6.3 v ±5% at 1.25 amps, secd No 3-5 v ±5% at 2 amps, secd No 4-6.3 v ±5% at 1.7 amps.	Power transformer	SPC	660263
T 102		TRANSFORMER, pulse, 3 sec-inner sec 90 turns, middle sec 90 turns, outer sec 135 turns, DC resistance-inner sec 2.32 ohms ±10%, middle sec 2.46 ohms ±10%, outer sec 12.4 ohms ±10%.	Pulse transformer	WE 7-P-20	226775
V 101		TUBE, electron, full wave high-vacuum rectifier.	Power rectifier	5R4GY	805147-1
V 102		TUBE, electron, beam power amplifier.	Voltage regulator	6Y6G	807594-1
V 103		TUBE, electron, RF pentode, sharp cutoff.	Regulator amplifier	6SH7	805881-1
V 104		TUBE, electron, klystron, integral cavity.	Oscillator	2K25	812535-1
V 105		TUBE, electron, min voltage regulator.	Voltage regulator	OB2	818236-1
V 106		TUBE, electron: Same as V-105.	Voltage regulator		

F-M Test Set

Reference Symbol		NAME OF PART and DESCRIPTION	FUNCTION	MFR. and DESIG. or JAN TYPE	CONT. or GOVT. DWG. or SPEC. No.
V-107		TUBE, electron, twin triode high-mu amplifier.	Amplifier	6SL7GT	804381-1
V-108		TUBE, electron: Same as V-107.	Amplifier and saw-tooth generator		
XV-101		SOCKET, electron tube, octal eight contact, mica-filled bakelite.	V-101	AMP M1P8TM	232294
XV-102		SOCKET, electron tube: Same as XV-101.	V-102		
XV-103		SOCKET, electron tube, octal, eight contact, mica-filled bakelite.	V-103	CNC 51B13416	212705
XV-105		SOCKET, tube, seven contact, mica-filled bakelite.	V-105	SPG	219150
XV-106		SOCKET, tube: Same as XV-105.	V-106		
XV-107		SOCKET, electron tube: Same as XV-103.	V-107		
XV-108		SOCKET, electron tube: Same as XV-103.	V-108		
Z-101		PICK-UP HORN, Army-Navy AT-68/UP, al alloy and silver, black and palladium flash, receives or radiates radio waves, 2-13/64 lg x 1-3/32 deep x 3-21/64 high overall, consists of 1 probe assembly (Sperry No 227600), 1 bead (Sperry No 227612), 1 probe (Sperry No 227613), 1 tube (Sperry No 240067), assy.	RF radiated energy pick-up	SPG	660159
Z-102		CABLE, output, Army-Navy CG-92A/U(8), AN Radio Frequency cable RG-9/U coaxial, flex, 51 ohms, 8 ft lg, sgle No .0285 AWG, stranded cop axial conductor, JAN-C-17 outer conductor double braided cop, inner braid silver coated (Anaconda Wire and Cable Co), assy.	Output and input signal transmission	SPG	660283
Z-103		OUTPUT SECTION, consists of waveguide with projecting type-end fitting, 2-3/4 lg x 1-3/16 wide x 2-3/8 high overall, assy.	Socket	SPG	660170
Z-104		WAVEGUIDE SECTION, consists of gasket (Sperry No 227456), H-plane bend (Sperry No 228941), and E-plane bend (Sperry No 812074), 5-1/8 lg x 2-1/4 wide x 4-3/16 high overall, assy.	Waveguide	SPG	660285
Z-105		ATTENUATOR, calibrated, br, consists of plate-guide, 12 lg with two attaching flanges, internal mechanism contains a platinized coated movable glass strip, 6-1/2 lg x 3 wide x 5-3/4 high overall, assy.	Power control	SPG	660524

TABLE OF REPLACEABLE PARTS - Continued

F-M Test Set

Reference Symbol		NAME OF PART and DESCRIPTION	FUNCTION	MFR. and DESIG. or JAN TYPE	CONT. or GOVT. DWG. or SPEC. No.
Z-106		DIAL AND WAVEMETER, consists of end plate (Sperry No 235635), T-section assy (Sperry No 660167), and wavemeter dial assy (Sperry No 660024) 8 lg x 6 wide x 7 high overall, assy.	Measures frequency	SPG	660169
Z-107		MOUNT, tube, consists of spring (Sperry No 228849), clip (Sperry No. 228970), term block (Sperry No 228962), tube cap (Sperry No 240360) tuner assy (Sperry No 236394), cover assy (Sperry No 705036), stop assy (Sperry No 240733), shaft (Sperry No 236205) and tube mount sub-assy (Sperry No 660301), 5-13/16 lg x 4-3/32 wide x 4-3/4 high overall, assy.	Klystron mounting	SPG	660164
Z-109		THERMISTOR MOUNT, br, sil-pltd, finish black paint, mounting for one ambient temperature compensating thermistor, and one bead thermistor in R.F. field which varies resistance with R.F. power, 2-7/8 lg x 1-5/8 wide x 3-3/16 high overall, assy.	Measures power	SPG	669160
Z-110		ATTENUATOR, dual position min-max, calibrated 4 db microwave attenuator of the parallel vain type, 11.191 lg x 8.375 wide, 8 (4 ea flange).	Microwave attenuator	SPG	660655
Z-111		CABLE, video, Army-Navy CG-638/U(6), AN Video Cable RG-11/U, coaxial, flex, characteristic impedance, 75 ohms, 61 eg, single 7 strands, 0.0159 cop axial conductor, solid dielectric polyethylene, AN RG-11/U, cop braid sgle outer covering synthetic resin of vinyl polymer type 0.415 OD.	Connect to test set	SPG	660349
Z-112		CORD, power, Army-Navy CX-337/U(6), six ft of two-conductor (No 16 AWG) unshielded power cable, fitted with male plug, Hubbell No 7084 and female plug, Hubbel No 7057, cable is similar to Whitney Blake Co No 591, consisting of two No 16 AWG conductors (ea 65 strands No 34 AWG wire), ru insulated, unshielded.	Connect to power source	SPG	243142
		AMPLIFIER UNIT, video, output driver, oscillator sweep generator 45 v, 2-11/16 wide x 2-7/16 high x 5-1/4 deep (115 v, 50-2400 c sgle ph), two input channels one for low impedance low level 1N23 crystal and one for high impedance high level for trigger, input voltage one, pulse 0.5 microsecond, 1000 to 3500 c, 0.05 to 5.0 v, two, same except amplitude of 2.0 to 150 v, total gain 450 v, mtl cabinet 4-5/8 lg x 2-3/4 wide x 3-3/8 high overall, assy.	Sawtooth generator and trigger amplifier	SPG	660662

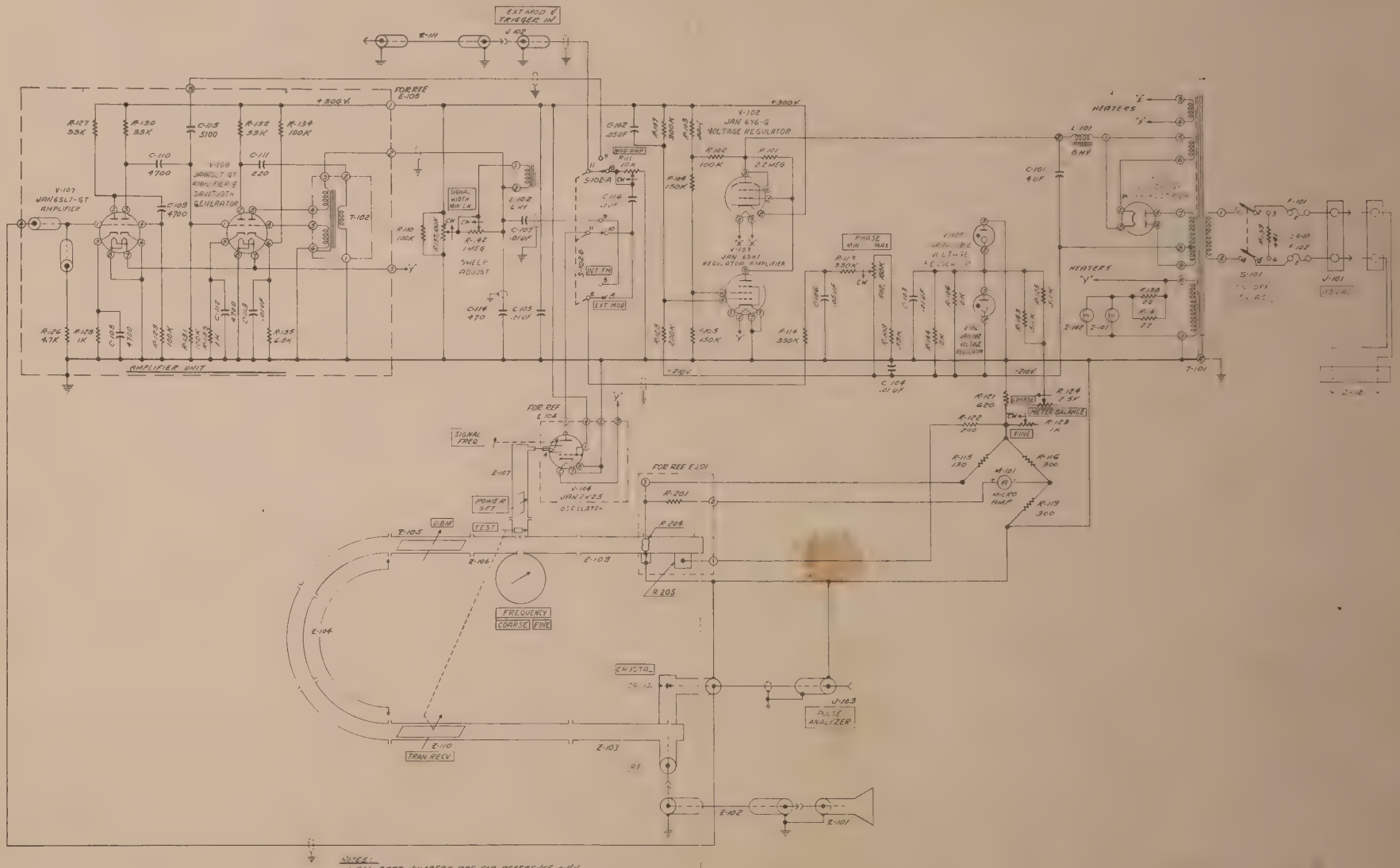
F-M Test Set

Reference Symbol		NAME OF PART and DESCRIPTION	FUNCTION	MFR. and DESIG. or JAN TYPE	CONT. or GOVT. DWG. or SPEC. No.
		BOARD, term, capacitor mounting, 9 fork-shape solder lug term, laminated plastic sheet, 4-5/8 lg x 2 wide x 3/32 thk overall.	Terminal board	SPG	835730
		BOARD, term, general purpose binding post strip, 5 fork-shaped solder lug term, laminated plastic sheet, 2-1/8 lg x 1-3/8 wide x 1/8 thk overall.	Terminal board	SPG	240422
		BOARD, term, resistor mounting, 9 fork-shaped solder lug term, laminated plastic sheet, 4-1/8 lg x 1-3/8 wide x 1/8 thk overall.	Terminal board	SPG	835731
		BOARD, term, resistor and capacitor mounting, 23 fork-shaped solder lug term, laminated plastic sheet, 7 lg x 2-1/8 wide x 1/8 thk overall.	Terminal board	SPG	713252
		BOARD, term, resistor mounting, 17 fork-shaped solder lug term, laminated plastic sheet, 4-5/8 lg x 2 in wide x 3/32 thk overall.	Terminal board	SPG	835732
		BUSHING, w/NUT, ni-pltd br and ni-pltd S, 3/8-32 thd.	To hold plumbing assy to panel	SPG	241724
		CORE, 1/2 diam x 0.827 lg, assy.	To prevent leakage to terminal block	SPG	235983
		GASKET, sq, br sheet, 1-5/8 sq x 0.003 thk.	Prevents leaks between assemblies	SPG	227456
		GASKET, rd, polyiron, 2.225 ID x 5.525 OD x 0.154 thk overall.	To prevent leakage from the tube mount assembly	SPG	228964
		HOLDER, fuse, for single 3AG ctg fuse, 2-5/16 lg x 11/16 diam overall.	Fuse mount	BSM HKP-HJWR	236260
		KNOB, crystal, consists of knob (Sperry No 235982), crystal holder (Sperry No 237987), and spring (Sperry No 236278) aprx 7/8 diam x 1-21/32 lg overall, assy.	Crystal mount	SPG	236279
		KNOB, irregular, black bakelite, 3/4 wide x 1-1/2 high x 5/8 thk overall, shaft hole 11/32 deep.	Test	SPG	243709
		KNOB, rd, black bakelite, 1-1/2 OD x 13/16 overall, shaft hole 41/64 deep.	Meter balance (fine), signal width, phase, internal FM and external modulation	KK S-380-64L-BB	251128

TABLE OF REPLACEABLE PARTS - Continued

F-M Test Set

Reference Symbol		NAME OF PART and DESCRIPTION	FUNCTION	MFR. and DESIG. or JAN TYPE	CONT. or GOVT. DWG. or SPEC. No.
		KNOB, rd, black bakelite, 1-1/2 OD x 13/16 thk overall, shaft hole 11/16 deep.	Signal frequency	SPG	240623
		KNOB, rd, fluted, black bakelite, 1-1/8 OD x 5/8 thk overall, shaft hole 7/16 deep.	Frequency (fine), power set, modulation amplitude	KK S-308-64BB	242448
		KNOB, rd, fluted, black bakelite, 1-3/8 OD x 9/16 thk overall, shaft hole 9/16 deep.	DBM	KK S-385-64BB	243064
		KNOB, rd, fluted, black bakelite, 1-3/8 OD x 1-1/8 thk overall, shaft hole aprx, 1/2 deep assy.	Frequency (coarse)	SPG	243080
		WRENCH, allen cap, hex, 20 lg w/right angle elbow 21/32 lg, .0937 across flats.	Wrench	SPG	243295
		WRENCH, allen cap, hex, 1-7/8 lg w/right angle elbow 39/64 lg, .0781 across flats.	Wrench	SPG	243296



NOTES:
1. ALL PART NUMBERS ARE FOR REFERENCE ONLY.
2. ALL VALUES EXPRESSED IN OHMS, MICROMICROFARADS, OR MICROHENRIES, UNLESS OTHERWISE INDICATED. K DENOTES 1000 OHMS, MEG DENOTES 1,000,000 OHMS.

Figure 7-1. Model 38A F-M Test Set Schematic Diagram

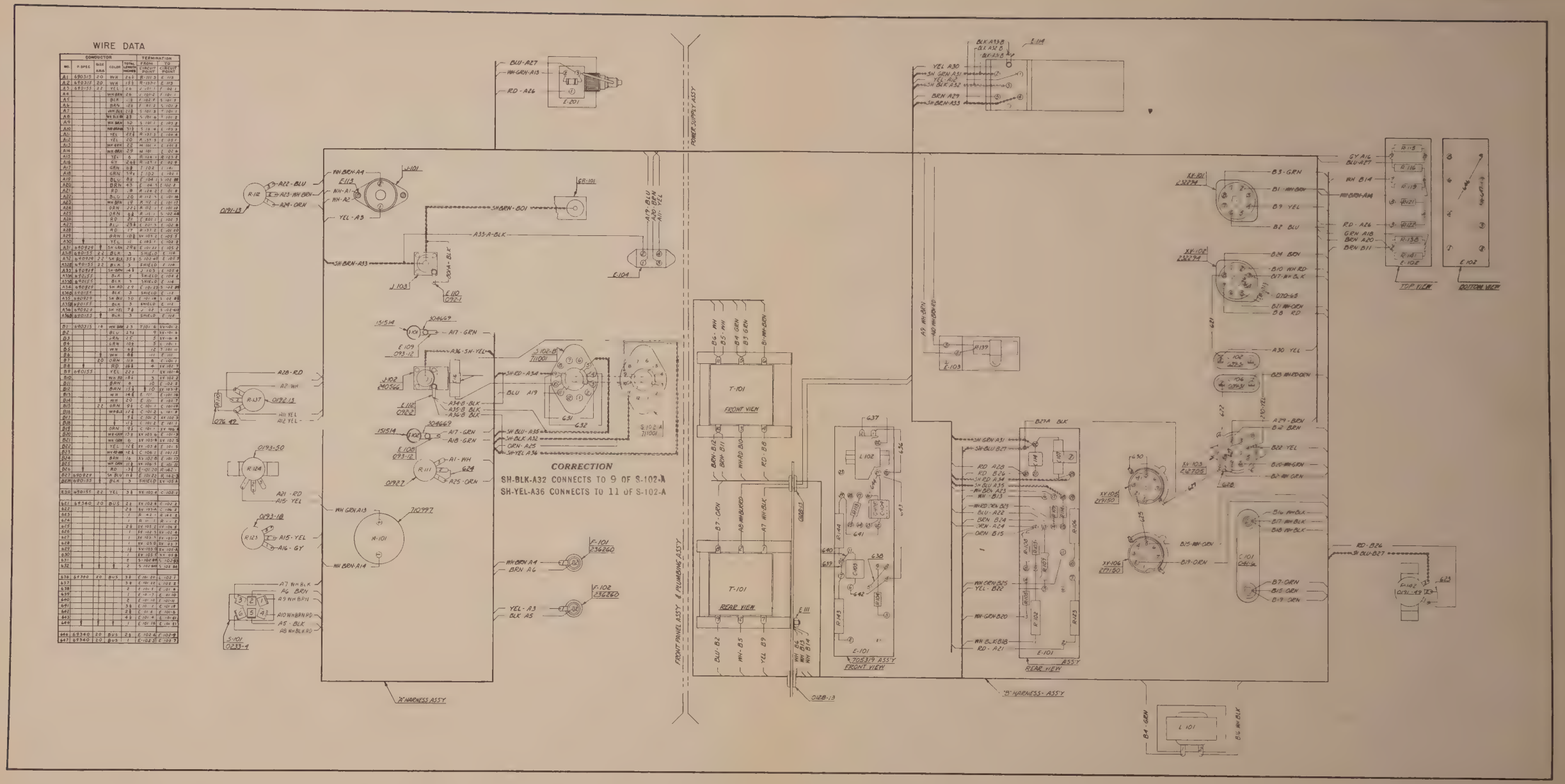


Figure 7-2. Power Supply Chassis and Control Panel Wiring Diagram

WIRE DATA

CONDUCTOR					TERMINATION	
NO.	P.SPEC.	SIZE A.W.G.	COLOR	TOTAL LENGTH INCHES	FROM CIRCUIT POINT	TO CIRCUIT POINT
201	690155	20	BLU	4 1/2	E-106-9	XV-107-5
202			YEL	3 1/2	E-106-11	XV-108-3
203			BLK	3 1/2	E-106-13	E-107-3
204			YEL	3	E-106-8	XV-108-6
205			BLU	3 1/2	E-106-14	XV-107-2
206			GRN	2 1/2	E-106-15	XV-107-4
207			YEL	2 3/4	E-106-16	XV-107-3
208			BLK	3	E-106-7	XV-107-B
209			RD	4	E-106-2	E-105-1
210	690240		COAX	3	E-106-17	XV-107-1
210B	690155	20	BLK	2	SHIELD	XV-107-A
211	690155	20	RD	3 3/4	E-107-1	E-106-10
212			GRN	4 1/2	-7	E-105-3
213			GRN	2 1/4	-2	XV-108-1
214			GRN	3 1/2	-2	E-106-12
215			RD	3	-1	XV-108-2
216			YEL	3	-4	XV-108-3
217			YEL	2 3/4	-5	XV-107-3
218			BLK	2 3/4	-9	XV-107-A
219			GRN	4	T-102-5	XV-108-4
220			GY	3 3/4	-3	E-105-2
221			BLU	4 1/4	-4	XV-108-5
222	690240	20	COAX	5	XV-107-1	E-105-4
222A	690155	20	BLK	3	SHIELD	XV-107-8
223	690155	20	BRN	2 3/4	XV-108-7	XV-107-7
224	690155	20	BRN	3 1/2	XV-108-7	XV-105-5
601	69340	20	BUS	1	E-106-7	E-106-6
602				1	E-106-4	E-106-3
603				1	E-106-2	E-106-1
604				2 1/4	E-106-7	E-106-4
605				2 1/4	E-106-5	E-106-2
606				3	E-106-13	E-106-8
611	69340	20	BUS	2 1/2	T-102-1	T-102-6
612				2 1/4	T-102-2	E-107-6
613				3	T-102-1	E-107-8
614				1	E-107-9	E-107-8
616				1 1/4	XV-107-6	XV-107-C
617				1 1/4	XV-107-8	XV-107-D
618				1 1/4	XV-108-8	XV-108-D

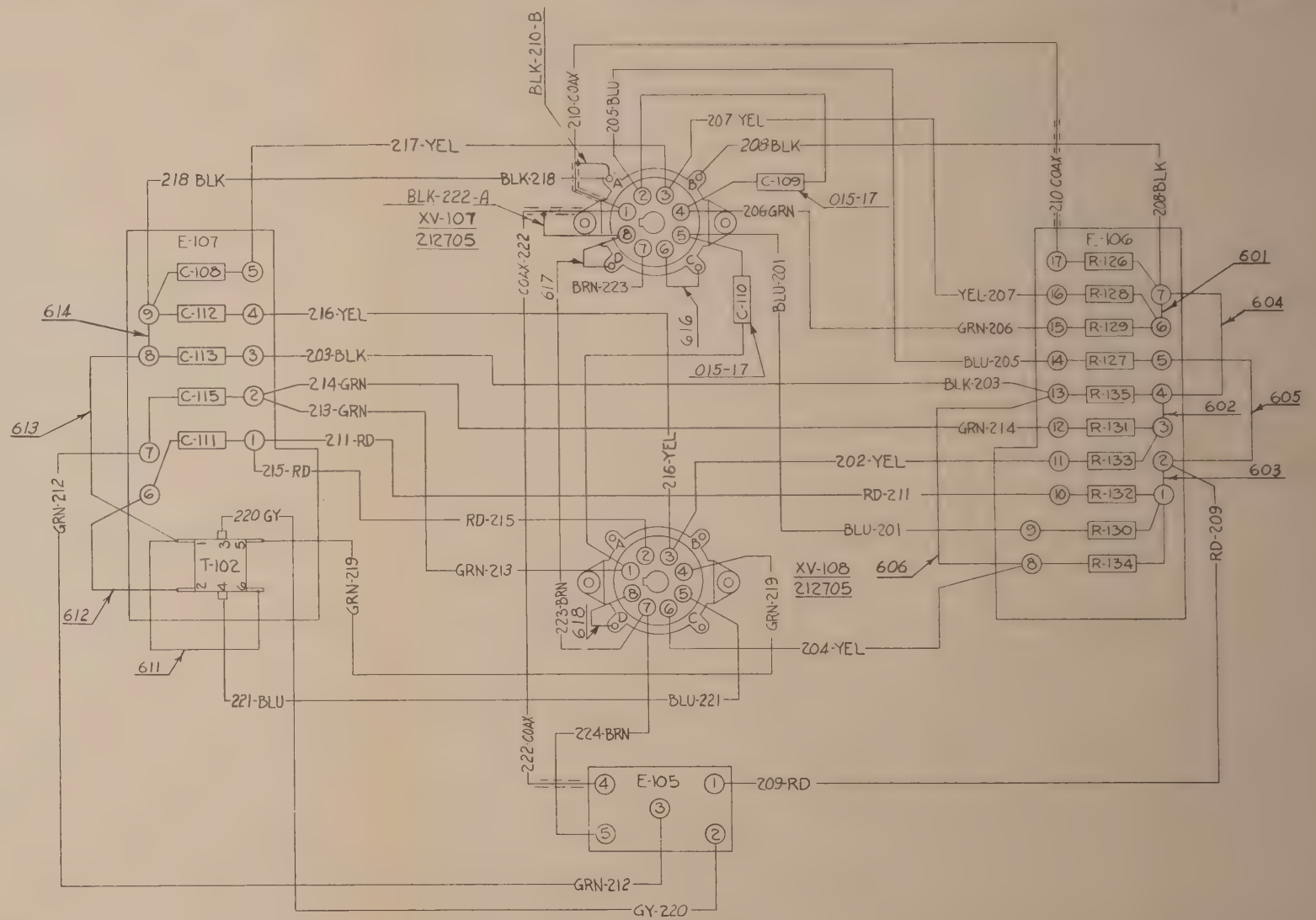


Figure 7-3. Amplifier Unit Wiring Diagram

ASSEMBLY OF TYPE N (B/U DESIGN) CONNECTORS

a. PARTS OF TYPE N (B/U DESIGN) CONNECTORS ARE SHOWN IN FIGURE 7-4A

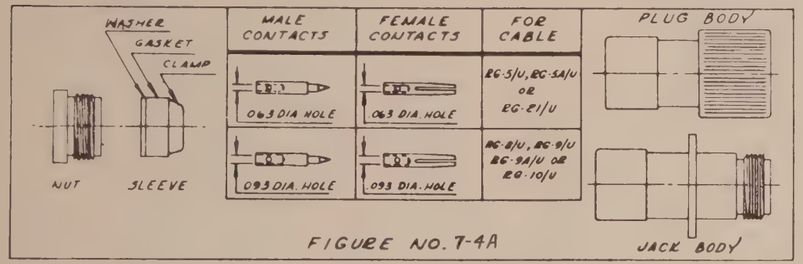


FIGURE NO. 7-4A

b. TYPE N (B/U DESIGN) CONNECTORS SHALL BE ASSEMBLED TO THE COAXIAL CABLES SPECIFIED IN FIGURE 7-4A AS FOLLOWS:

1. CUT OFF END OF CABLE SHARPLY & SQUARELY.

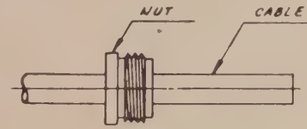


FIG. NO. 7-4B

2. CUT OFF JACKET SQUARE & EVEN 1 INCH FROM END, BEING CAREFUL NOT TO NICK BRAID.

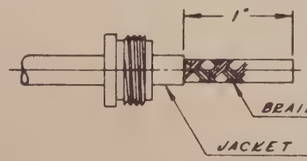


FIG. NO. 7-4C

3. FAN BRAID OUT & CUT OFF DIELECTRIC & INNER CONDUCTOR UNDER BRAID 3/4 INCH FROM END OF JACKET. (PURPOSE OF THIS IS TO LEAVE SQUARE END)

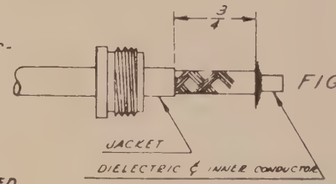


FIG. NO. 7-4D

4. TAPER BRAID AS SHOWN & SLIDE SLEEVE OVER TAPERED BRAID TO FIT TIGHT AGAINST JACKET. BE SURE INNER SHOULDER OF SLEEVE FITS SQUARELY AGAINST END OF JACKET & THAT IT CLEARS ALL BRAID WIRES.

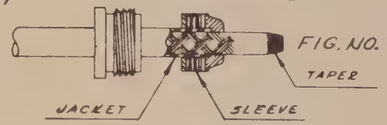


FIG. NO. 7-4E

5. WITH SLEEVE IN PLACE, COMB OR FAN OUT BRAID, TRIM TO 3/16 INCH FROM END OF SLEEVE & FOLD BACK SMOOTH AS SHOWN. MAKE CERTAIN THAT NO STRANDS OF BRAID REACH THE GASKET. THEN CUT THE DIELECTRIC 5/32 INCH FROM BRAID, (BEING SURE TO CUT SQUARE & CAREFUL NOT TO NICK INNER CONDUCTOR) & CUT OFF INNER CONDUCTOR 3/16 INCH FROM END OF DIELECTRIC.

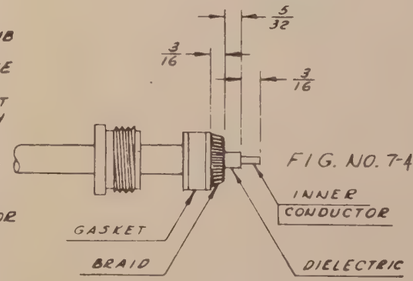


FIG. NO. 7-4F

† INNER CONDUCTOR OF RG-21/U MUST BE SILVER PLATED BEFORE SOLDERING

6. † TIN THE INNER CONDUCTOR & THE INSIDE HOLE OF THE CONTACT. SLIP THE CONTACT IN PLACE SQUARELY AGAINST END OF DIELECTRIC. & SOLDER, USING, 60-40 SOLDER & ROSIN FLUX (HOLDING CONTACT AGAINST DIELECTRIC) USING A POINTED SOLDERING IRON TO PREVENT DISTORTION OF DIELECTRIC DUE TO EXCESSIVE HEATING. REMOVE ALL EXCESS SOLDER & FLUX. EXAMINE CABLE END TO MAKE SURE INNER CONDUCTOR IS IN THE CENTER OF THE DIELECTRIC.

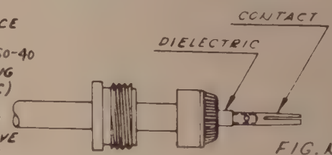


FIG. NO. 7-4G

NOTE: ALTHOUGH A FEMALE CONTACT IS SHOWN, THE PROCEDURE APPLIES TO ALL CONTACTS SHOWN IN FIGURE 7-4A

7. PUSH CABLE ASSEMBLY INTO A JACK OR PLUG BODY SO THAT DIELECTRIC FITS SQUARELY AGAINST INSIDE OF INSULATOR. THEN SLIDE NUT INTO BODY & SCREW INTO PLACE WITH A WRENCH UNTIL MODERATELY TIGHT, HOLDING THE CABLE & BODY RIGIDLY. DO NOT TURN THE BODY. THE FINAL ASSEMBLY MUST BE AS FOLLOWS:

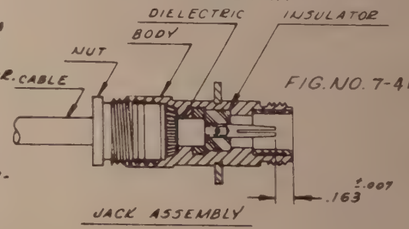


FIG. NO. 7-4H

JACK ASSEMBLY

(a) SOCKET END OF A FEMALE CONTACT SHALL BE .163 +.007 FROM END OF BODY AS SHOWN IN FIGURE 7-4H

(b) SHOULDER OF MALE CONTACT SHALL BE .221 +.007 FROM END OF PLUG CONTACT AS SHOWN IN FIGURE 7-4I

(c) ASSEMBLY SHALL WITHSTAND A PULL OF 20 POUNDS ON THE CABLE WITHOUT LOOSENING.

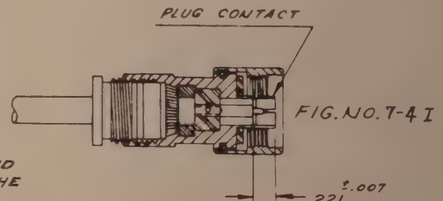


FIG. NO. 7-4I

PLUG ASSEMBLY

Figure 7-4. Output Cable CG-92A/U(8) Fabrication Notes

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$$6.28 \times 400 = 2512$$

$$25\overline{)2.00} \rightarrow 10^{-9}$$

$$.01 \times 10^{-9}$$

$$.0000002512$$

$$X_C = \frac{1}{2\pi f C}$$

$$.8000$$

$$.0000\ 2512\overline{)1}$$

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